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Getting Started Quickly with MIPAV

This chapter provides information to help you get started quickly using MIPAV. It explains basic tasks, such as starting and ending the program; opening and loading images, creating new images, and saving and printing images. In addition, it discusses how to create volumes of interest (VOIs),

how to compare images using alphablending, and how to customize the program.

Starting MIPAV

Starting MIPAV differs depending on your platform. To begin a MIPAV session, do the following:

If your platform is . . .	Then . . .
Windows 95, 98, 2000, NT, XP	Select Start > Programs > mipav > mipav.
Linux	Open a shell. Go to the directory where you downloaded the installer. At the prompt, type **sh ./installMIPAV.bin**.
Mac Operating System (OSX)	Unzip the installer (StuffIt expander may open automatically). Double-click the installer icon on your desktop.
Unix OS (Sun Solaris, OS/2 Warp, and others	In a shell tool, command tool, or terminal window, go to the directory where you installed MIPAV. At the prompt, type **./mipav**.

Both the Medical Image Processing, Analysis & Visualization (MIPAV) window (Figure 6) and the Output window (Figure 7) appear on your desktop. You can access most of MIPAV's features from the menu bar in the MIPAV window.
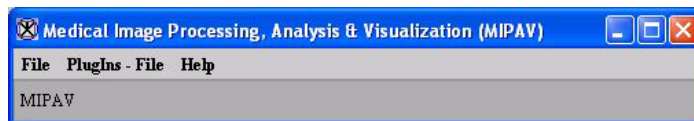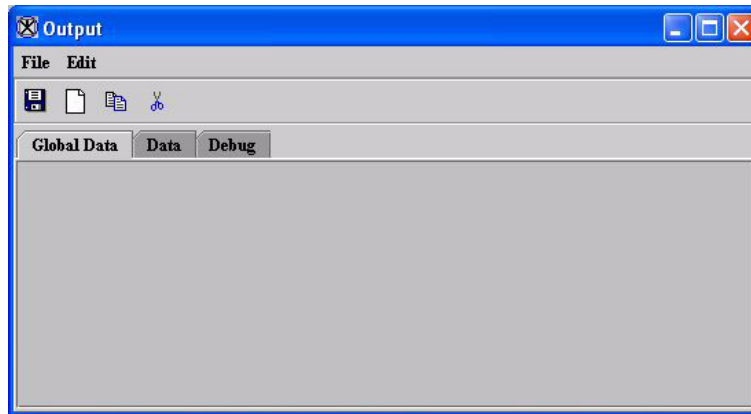

Figure 6. The MIPAV window that appears after starting the program

File	**Save Messages**—Saves all of the messages displayed on the currently open page (e.g., Global Data page, Data page, or Debug page). When you select this command, the Save dialog box opens.
Edit	**Clear**—Clears all of the messages that are displayed on the currently open page. Caution: Be sure you want to use this command. There is no undo.
	Copy—Copies the selected text on the currently open page.
	Cut—Removes the selected text from the currently open page.
	Select All—Copies all of the text on the currently open page.
Save messages icon	Saves all of the messages displayed on the currently open page. When you select this command, the Save dialog box opens.
Copy	Copies the selected text on the currently open page.
Paste	Pastes copied text into the currently open page at the cursor point.
Cut	Removes the selected text from the currently open page.
Global Data	Displays all messages for all images worked on during a particular session.
Data	Displays messages that apply to the currently active image.
Debug	Displays debugging information for the currently selected image.

Figure 7. Output window

After starting MIPAV, you can open and load image files, create new images, access DICOM images, customize MIPAV, and end the session.

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Opening and loading image files

The first step in image visualization is displaying the image file. MIPAV displays images in windows that you can move around the desktop (Figure 8). You can display as many image datasets as needed as long as your computer has enough allocated memory. The amount of memory required depends on the number of image datasets that are open and the size of each image file. For more information, see "Managing memory resources" on page 97.

You can either open or load an image file. When you *open* an image file, MIPAV displays the image in a new image window. *Loading* an image file imports the file into an image window in which another image file is open. In other words, two image files share a common image window.

Tip: If you need to compare two images that reside in different datasets, do the following:

1 Open the first image file. The image appears in a new image window.

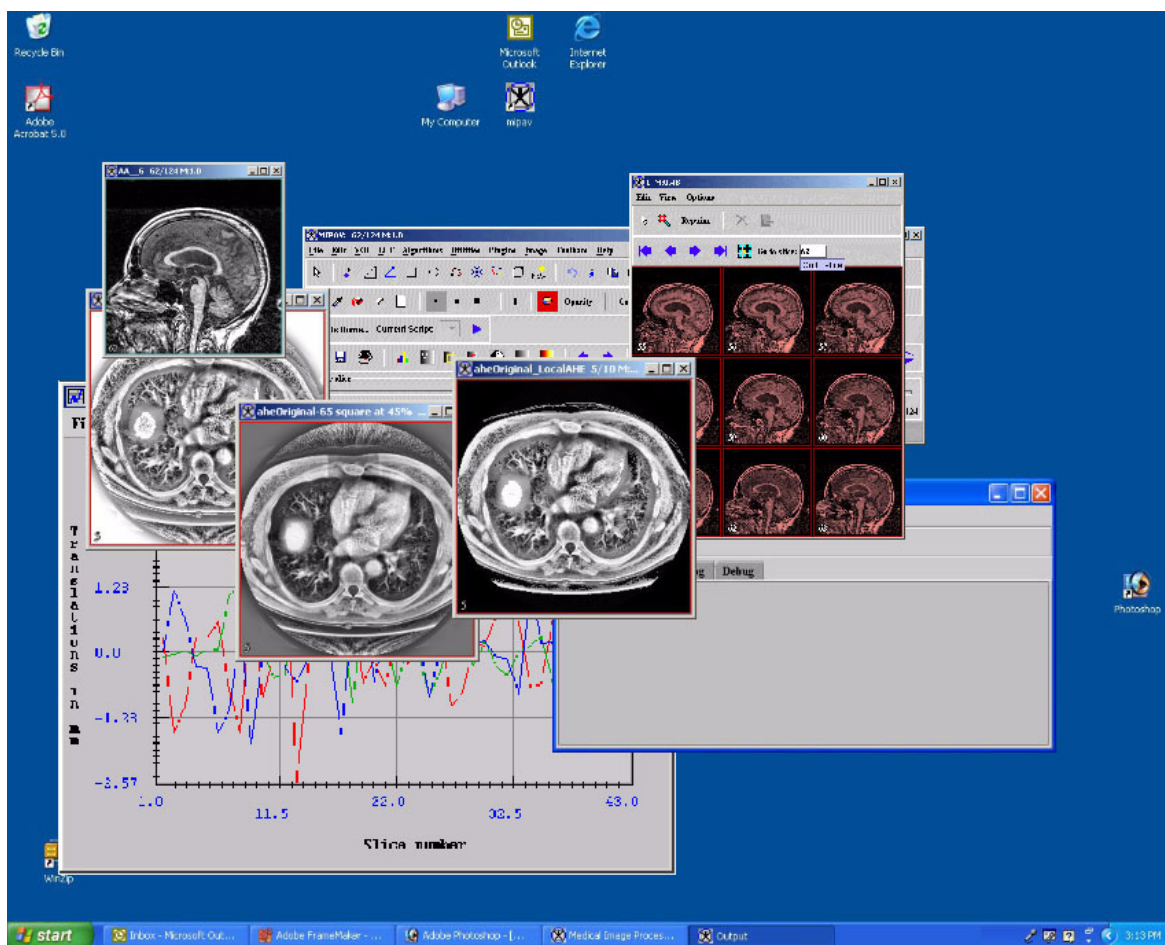*2 Load* the next image file. The image appears in the same image window as the first image file.

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Figure 8. Desktop showing the MIPAV window, the Output window, and multiple image windows

Note: Only two images can occupy an image window. If you load a third image, it overwrites Image B.

You can use MIPAV to open or load files of a variety of medical and generic graphic and multimedia file formats. Table 1 lists the format,

extension, and whether MIPAV can read or write files of a particular format. The *extension*, which is the last few characters of a file name including the period, indicates the file format. In the file name DOE255.ima, the

extension *.ima* indicates that the file is stored in DICOM format. In the table, the Read column indicates that MIPAV can display image files of a particular format. When a file is read, it is stored in main memory so that MIPAV can access it. The Write column means that MIPAV can copy the data from the memory to a storage destination, such as your hard disk. In this context, *write* is synonymous with *save*. For more information on file formats, refer to Chapter 4 in the *MIPAV User's Guide*.

Table 1. File formats

Manufacturer or Application	Extensions	Read	Write
Adobe Photoshop	PSD	Y	Y
AFNI	HEAD, BRIK	Y	Y
Analyze	IMG	Y	Y
Audio Video Interleave	AVI	Y	Y
BIORAD	PIC	Y	N
Bruker	2dseq	Y	N
Cheshire	IMG or IMC	Y	Y
DICOM	DCM, IMA	Y	Y
FITS	FTS	Y	N
FreeSurfer image	COR	Y	N
FreeSurfer surface (ASCII file)	ASC	Y	N
GE – Genesis 5X and LX	SIG	Y	N
Graphics Interchange File	GIF	Y	N
ICS (Integrated Collection System)	ICS	Y	N
Interfile	HDR	Y	N
Joint Photographics Experts Group	JPEG,JPG	Y	Y
Laser Scanning Microscope (Zeiss)	LSM	Y	Y
Macintosh PICT	PICT	Y	Y

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Table 1. File formats (continued)

Manufacturer or Application	Extensions	Read	Write
Medical Image Network Common Data Form including ROIs	MNC	Y	Y
MICRO-CAT	LOG	Y	N
Microsoft Windows Bitmap	BMP, DIB	Y	Y
Medical Research Council (MRC)	MRC	Y	Y
PC Paintbrush	PCX, DCX, PCC	Y	Y
Portable Network Graphic	PNG	Y	Y
QuickTime--Apple	QT, MOV	Y	Y
RAW	RAW	Y	Y
Siemens – Magnetom Vision	IMA	Y	N
Sun Raster	RS, RAS	Y	Y
Tag Image File Format	TIFF	Y	Y
Truevision Graphics Adapter	TGA, VST, VDA, ICB, TPIC	Y	Y
X BitMap	XBM	Y	Y
X PixMap	XPM	Y	Y

Opening image files

You can open a single image file or multifiles. *Multifiles* are image datasets that are composed of multiple files.

To open an image file

1 Do one of the following in the MIPAV window:

- *Opening other types of image files:* Select File > Open > Image.

- *Opening a multifile:* Select File > Open > Multifile.

Tip: To form a 4D dataset in Analyze format, use the Multifile command to open

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a series of individual 3D Analyze, formatted, consecutively ordered images.

For example, you can use the Multifile command to open an array of .tiff, .jpeg, .bmp, etc., files if their file names meet the following format:

*foo*_001.tiff, *foo*_002.tiff, *foo*_003, etc.

where *foo* is the name of the file.

The Open Image dialog box (Figure 9) opens.

Note: If an image file is already open on your desktop, the commands on the File menu vary slightly. Select Open > Multifile(A) to open an image dataset that consists of multiple files. Select Open > Image(A) to open a single image file.

2 Navigate to the directory where the file is stored.

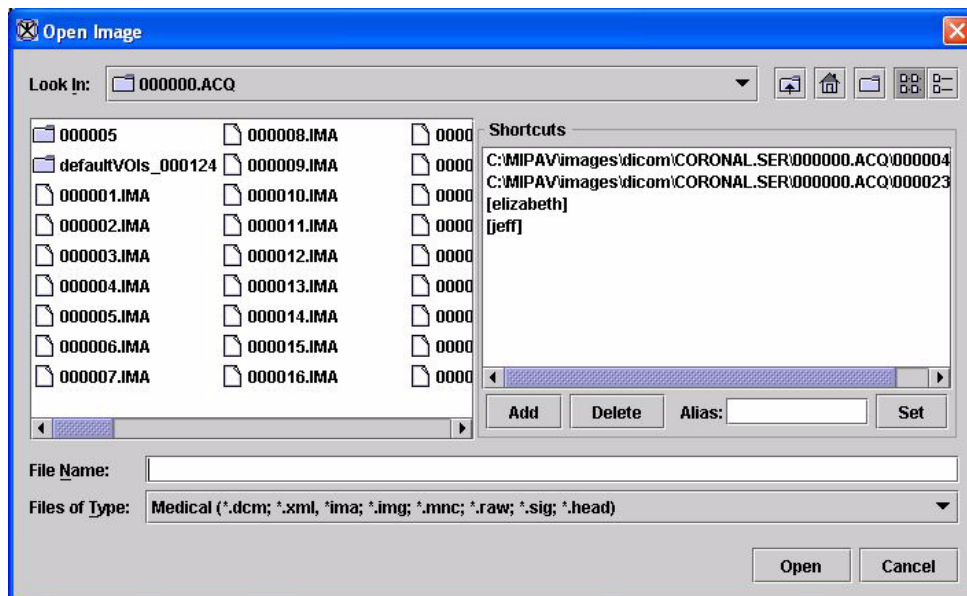**3** Select the type of file in the Files of type list (shown in Figure 9).

Figure 9. Open Image dialog box showing shortcuts

4 Select the file. The name appears in File name.

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5 Click Open. While the file is opening, a status message appears. Then the status window closes, and MIPAV displays the image in a new image window (Figure 10).

Figure 10. An image displayed in an image window

Note: After the first image is opened, the MIPAV window changes. It includes more menus, the title bar displays more information, and toolbars appear. Because the MIPAV window is context sensitive, it displays or hides commands on the menus depending on the characteristics of the image file that is opened. If you opened a dataset file that contains more than one image, a slider also appears.
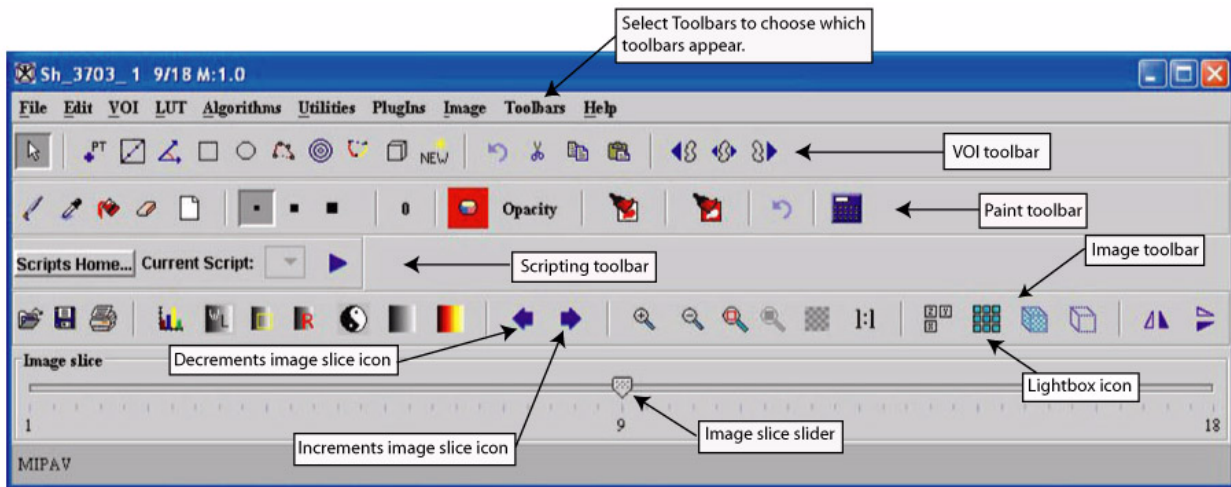
Figure 11. Expanded MIPAV window showing toolbars, image slider, and more menus after the first image is opened

> **Note:** If you prefer for MIPAV to use the style of Open and Save dialog boxes that are used by the operating system (e.g., Microsoft Windows, Unix, or Apple) on your computer, read the section on "Using platform-specific Open and Save dialog boxes" on page 90.

Loading image files

You can either *open* or *load* image files. When you *open* an image file, MIPAV displays the image, by itself, in a new image window. When you *load* an image file, MIPAV imports it into an existing image window. The loaded image shares the same window with another image file. Loading a file allows you to compare two datasets.

In MIPAV, the first image opened in an image window is referred to as *Image A*. When you load, or import, a second image in the window, MIPAV refers to the second image as *Image B*.

To load an image file

1 Open the first image by selecting File > Open > Image(A) or File > Open > Multifile(A). The image appears in an image window.

2 Select the title bar of the image window (in this case, the image that you just opened) in which you want to load another image.

3 Select any of the following:

- File > Load > Image(B) from Frame—To load another image dataset from an already opened image dataset to another opened image dataset

- File > Load > Image(B) from File—To load another image dataset

- File > Load > Multifile(B)—To load a multifile image dataset

Tip: You can use this option to load a series of individual 3D Analyze formatted, consecutively ordered images to form a 4D dataset in Analyze format.)

Note: The abbreviations (A) or (B) appear after some commands. (A), which is the abbreviation for "Image A," indicates that the option is applied to the first image opened in an Image window. (B), which is the abbreviation for "Image B," indicates that the option is applied to second image loaded in an Image window. For example, if you select Close Image (B), MIPAV closes the second image (Image B) that was loaded in the image window.

The Open window appears.

4 Select the image file you want to load.

5 Click OK.

If MIPAV does not recognize the type of file based on its extension, the Choose File Type dialog box opens. Select the file type and click OK.
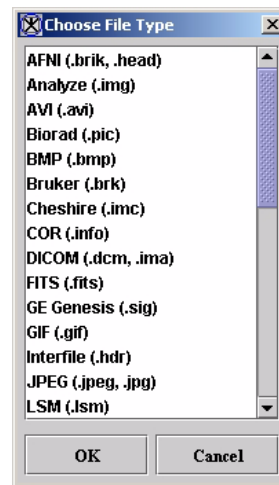
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Figure 12. Choose File Type dialog box

Note: MIPAV recognizes files types by the file extension. For example, if you select an image named Smith.tiff, MIPAV tries to open the file as a tiff file. If that image is actually a *.jpg* file and mistakenly has the *.tiff* extension, MIPAV cannot open the file.

As the image file is loading, a pop-up window appears with the status. When the image file finishes loading, it appears in the image window. At this point, take note of several changes:

- MIPAV pseudo-color was applied to the images in the image window. The pseudo-color indicates that two images are in the window.

- In the MIPAV window, the Active Image and Alphablending slider appears. The slider allows you to control which image is displayed in the foreground of the window. The image in the foreground is the *active image*. You can adjust the translucency of the alpha channels in each image using the technique.

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Selecting views

A *view* refers to the way an image file is displayed. A view indicates how many images are shown at one time and whether images are advanced manually or automatically. Depending on the view, the size and shape of the image window in which an image is displayed can vary.

MIPAV allows you to display images using the following views:

- Default (explained in this section)

- Animate

- Cine (movie) ▣ (explained in this section)

- Lightbox ▦ (explained in this section)

- Link to another image

- Surface plotter

- Surface render

- Triplanar ▣

- Triplanar—dual

- Volume render (shear)

- Volume render

Note: This section explains how to display image files in default, lightbox, and cine views. To learn how to display image files in other views, see Chapter 6 in the *MIPAV User's Guide.*

Understanding image windows

An *image window* (Figure 13) consists of a title bar that displays the name of the image file and the magnification level. If there is more than one image in the dataset, the title bar displays the number of the current image that is displayed and the total number of images in the dataset.
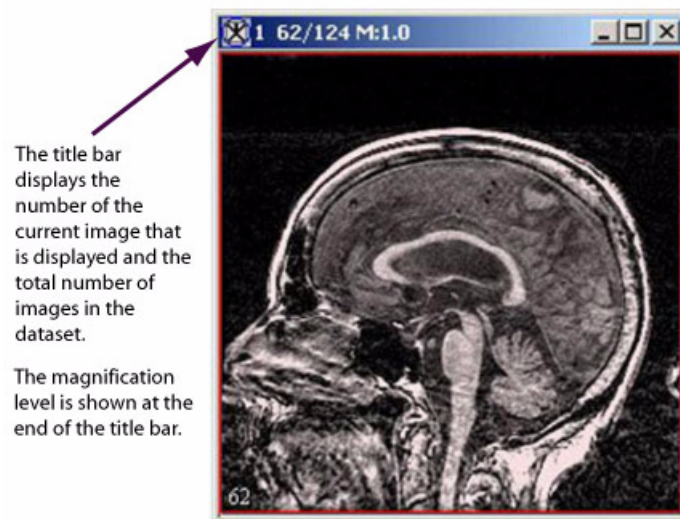

The title bar displays the number of the current image that is displayed and the total number of images in the dataset.

The magnification level is shown at the end of the title bar.

Figure 13. An image window

Moving images

You can move an image window around your desktop by clicking the title bar and dragging the window to a new location. Sometimes, depending on the view, a toolbar or menu bar also appears in the image window. For example, the image window using the light box view contains a toolbar and menu bar.

Displaying images using the default view

In the *default view*, MIPAV displays the images in a dataset one at a time in an image window (Figure 14). This window can display datasets of any dimension.
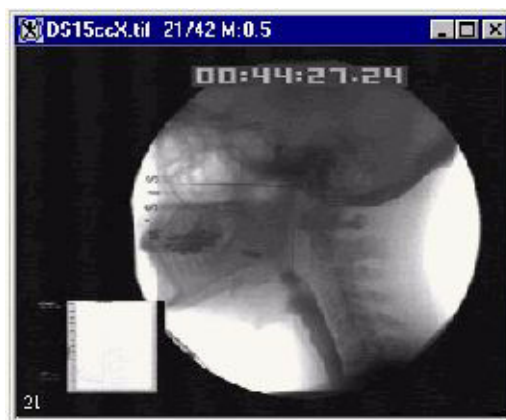
Figure 14. An image in an image window (default view)

Displaying images using the lightbox view

The *lightbox view* is similar to the default view, except that all images in the dataset appear in one window at the same time (Figure 15).

To display images in the lightbox view

1 Open an image file. The image appears in an image window.

2 Select the image window. Do one of the following in the MIPAV window:

- Click Lightbox ▦.

- Select Image > Views > Lightbox.

The image now appears in a lightbox view.

Tip: To magnify a portion of the image, click Magnification Region 🔍 and move the pointer to the image section to be magnified. Click Default Mode ▫ when finished.
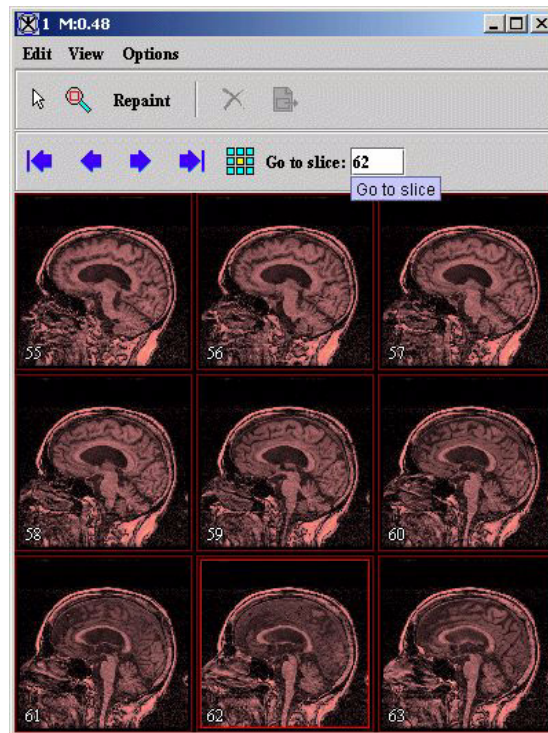

Figure 15. An image dataset shown in a lightbox view

3 Select Options > Settings in the lightbox view window to adjust the size and shape of the window.

The Lightbox Settings dialog box (Figure 16) opens.

4 Indicate the number of rows and columns, the grid size, frame border size, color settings, and the magnification. For more information on these attributes, see volume 1 of the *MIPAV User's Guide*.
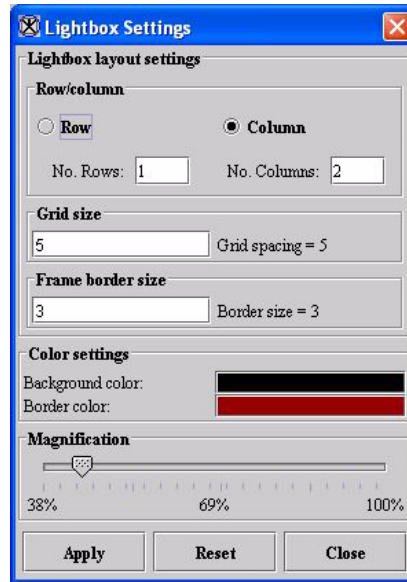
5 Click Close when complete.

Figure 16. Lightbox Settings dialog box

Tip: Double-clicking an image in the lightbox view updates the 2D image frame to that image.

Displaying images using the cine view

When you view an image file in cine view, MIPAV automatically advances images one frame at a time. The effect is much like a film loop.

To display images in cine view

1 Open an image file. The image appears in the default image window.

2 Select Image > Views > Cine (Movie). The images in the image window are advanced automatically.

Adjusting magnification

MIPAV allows you to magnify images from ¼ to 32 times the size of the original image. Using the magnification tools, you can magnify or minify the entire image or just a portion of the image. The magnification box is much like a traditional magnifying glass, except it can also *minify*, or reduce the level of magnification, a portion of the image.

This section explains how to change the magnification level of the image using the icons on the image toolbar (Figure 17) in the MIPAV window.
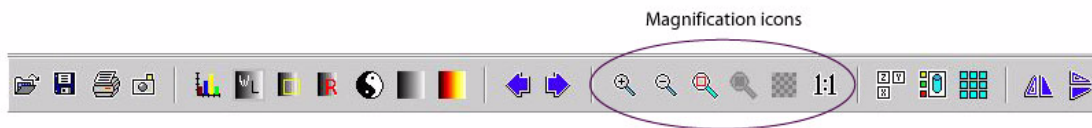

Figure 17. Magnification icons are located on the image toolbar

To learn how to set the magnification level using the other methods, see volume 1 of the *MIPAV User's Guide*.

To adjust the magnification level using the image toolbar in the MIPAV window, you can use the following:

- Magnify Image icon
- Minify Image icon
- Magnify Region icon
- Original Magnification icon 1:1

Magnifying images

To magnify an image, click Magnify Image . Each time you click the Magnify Image icon, the image doubles in size. If an image is too large for

the current window size, scroll bars appear, and you may need to manually adjust the size of the window.
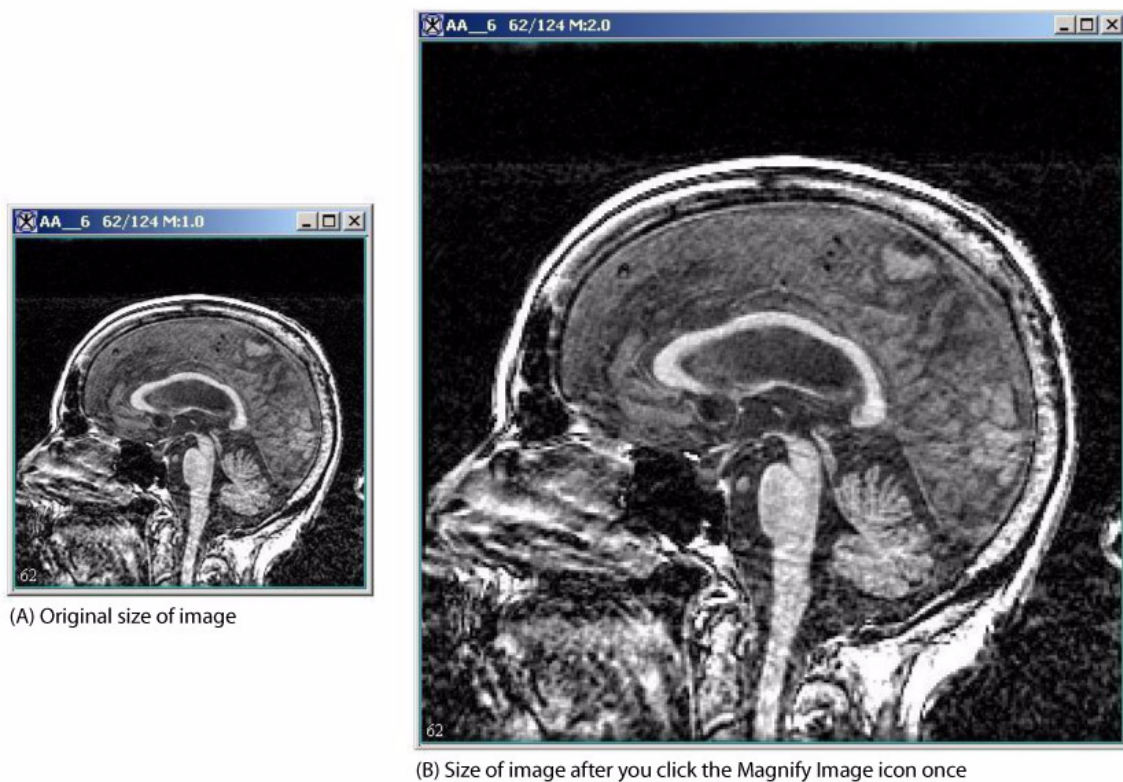
Figure 18. **Original image and magnified image achieved from click the Magnify Image icon once**

Reducing the magnification level

To reduce the magnification level of an image, click Minify Image . Each time you click the Minify Image icon, MIPAV reduces the magnification level of the image by half.
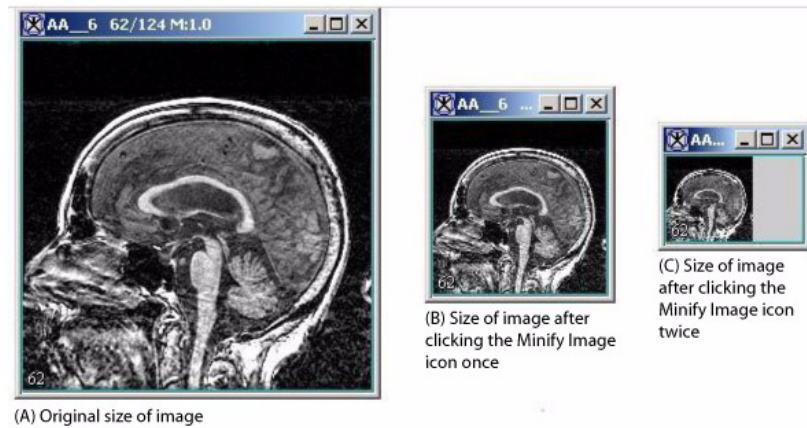
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Figure 19. Minified images that result from using the Minify Image icon

Restoring the original level of magnification

To return the image to its original size or original level of magnification,

click Original Magnification 1:1 .

Magnifying regions within images

The Magnify Region icon allows you to view a square portion, or region, of the image at a specific magnification level.

Note: If you have loaded two images into the same image window, the Window

Region of Image B icon appears on the toolbar. Use this icon to view a region on the second image, or image B.

To use the Magnify Region icon

1 Open an image.

2 Click Magnify Region and move it over the image.

As you move the mouse over the image, the Magnify Region icon displays a magnified square region in the image in a red box. The number at the left corner of the square is the magnification level.
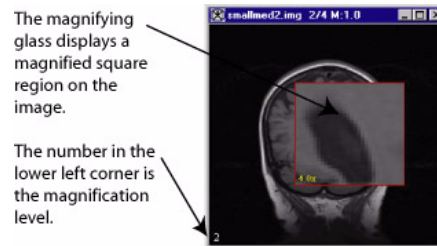
Figure 20. Magnified square region on an image

To change the size of the magnified region

You can change the size of the magnifying region to allow you to view larger or smaller regions of the image.

1 Right-click on the image while displaying a magnified region. The Magnify dialog box appears.
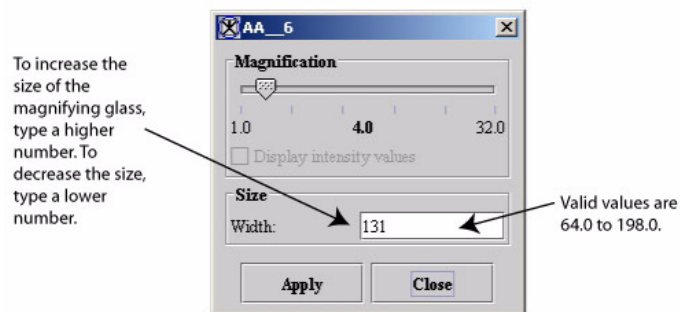
Figure 21. Magnification dialog box

2 Type either a higher number for a larger region or a lower number for a smaller region in the Width box. Valid values range from 64.0 to 198.0.

3 Select Apply. The size of the magnified region, or square, either increases or decreases in size.

Figure 22. Magnifying glass at different sizes

INCREASING AND DECREASING THE MAGNIFICATION LEVEL

Changing the magnification level of the magnified region works similarly to changing the size of the magnified region.

To change the magnification level

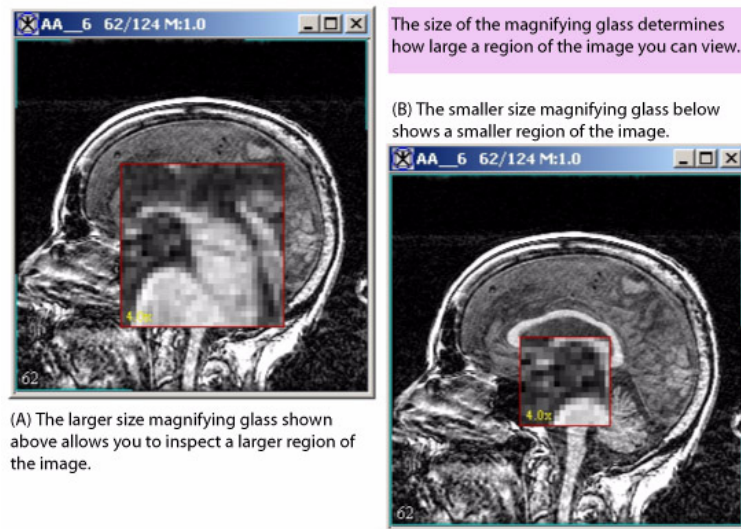**1** Right-click on the image while displaying a magnified region. The Magnify dialog box (Figure 23) appears.

The Display intensity values check box only becomes active when you move the magnification slider to a high enough magnification.

To increase the magnification level, move the slider to the right. To decrease the magnification level, move the slider to the left.
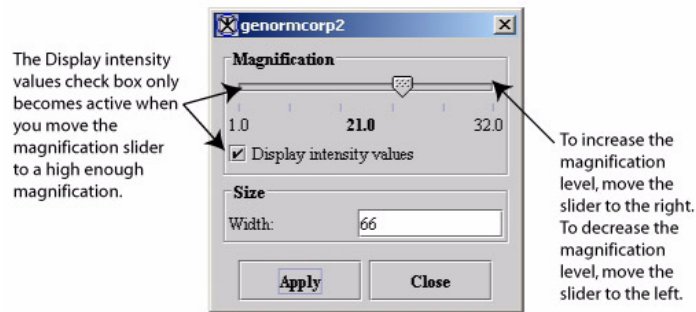
Figure 23. Magnification slider on the Magnification dialog box

2 Slide the Magnification slider (Figure 23) to the right to increase the magnification level or to the left to decrease the magnification level.

Note: When you slide the Magnification slider right past a certain point, the Display intensity values check box becomes active.

3 Select Apply.

Tip: To review or compare a magnified region of the image with the same region at its original magnification, press Shift. Release the key when to return to the magnified view.

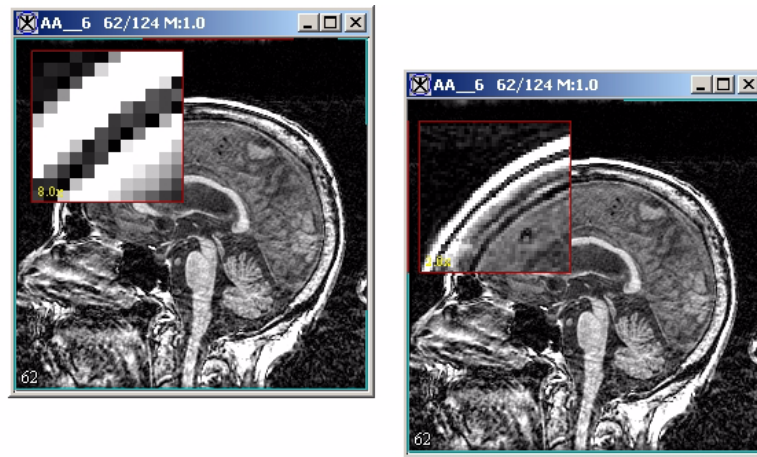The magnification level shown in the magnified region changes to the level you specified.

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Figure 24. Two different magnification levels in the same magnified region

SHOWING INTENSITY VALUES THROUGH THE MAGNIFICATION GLASS

The Display intensity values check box on the Magnify dialog box allows you to display the intensity values within a magnified region of the image.

To show the intensity values

1 Right-click on the image while displaying a magnified region. The Magnify dialog box appears.

2 Select the Display intensity values check box.

If the check box is not available, or dimmed (as it is in Figure 21), increase the magnification by sliding the magnification slider to the right until the check box is active (refer to Figure 23).

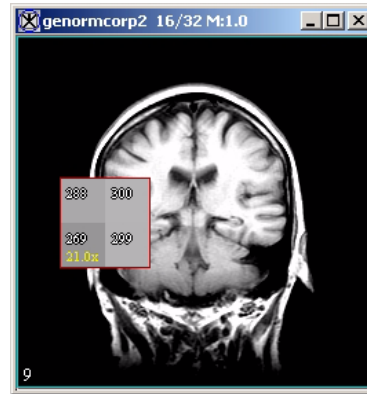3 Move the mouse over the image. The intensity values appear within the magnified region (Figure 25).

Figure 25. An image window displaying intensity values for a magnified region in the image

Tip: If you hold down the middle mouse button, MIPAV writes the intensities by position within the image to the Data page of the Output window. You can then save these messages and print them.

Improving contrast, adding color, and creating negative images

This section explains how to improve image contrast, add color to images, and create negative images by applying a quick lookup table (LUT), generating and modifying a histogram, applying pseudo-color LUTs, and creating negative images by inverting their color.

histogram—A histogram is a representation of a frequency distribution by means of rectangles whose widths represent class intervals and whose areas are proportional to the corresponding frequencies.

lookup table (LUT)—A lookup table maps the frequency distribution in a histogram to pseudo-color values.

Figure 26. Quick LUT icon on the image toolbar

Improving contrast on images quickly

MIPAV provides the following quick ways to improve the contrast on images:

- Using the Quick LUT icon
- Using the right mouse button
- Using the Adjust Window and Level icon

USING THE QUICK LUT ICON

An easy way to improve the contrast in an image is by using the Quick LUT icon, which is located on the image toolbar in the expanded MIPAV window (Figure 26).

To use this icon, you first need to open an image to display the expanded MIPAV window.

To use the Quick LUT icon

1 Open an image file. The image appears in an image window. If an image was not previously open, the initial MIPAV window expands to include all of the menus.

2 Select the image window.

3 Click Quick LUT .

4 Hold down the left mouse key and draw a rectangle on a portion of the image.

5 Release the left mouse key. Based on the amount of dark and light in the portion of the image that you selected, MIPAV changes the contrast in the image.

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Repeat steps 3 through 5 as often as you wish to further improve image contrast. When you are satisfied with the contrast, save the image.
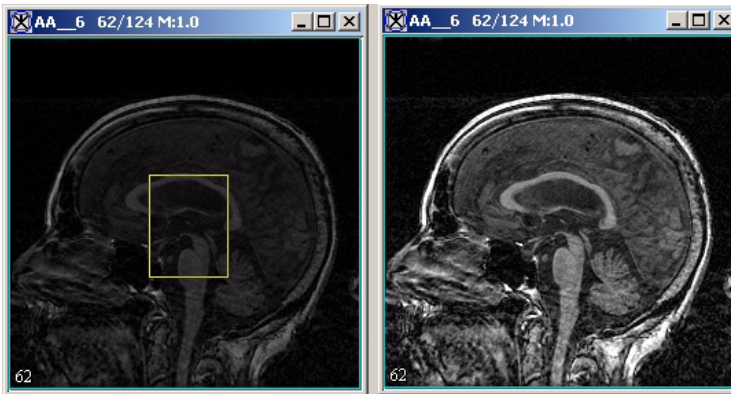
Figure 27. Images before and after applying the Quick LUT icon

USING THE RIGHT MOUSE BUTTON

The right mouse button provides you with a very simple way of changing image contrast. To do so, open an image and then hold down the right mouse button and drag it around the screen. The cursor changes from a red cross to   .

When you drag the cursor up and down or across the image, the image may become darker and gradually disappear or become lighter in appearance. At some points you may be able to create a negative of the image.

USING THE ADJUST WINDOW AND LEVEL ICON

The Adjust Window and Level icon on the Image toolbar provides another way to change the contrast of images.

To adjust image contrast

1 Open an image file. The image appears in an image window. If an image was not previously open, the initial MIPAV window expands to include all of the menus.

2 Click Adjust Window and Level ▣.

The Level & Window dialog box (Figure 28) appears.
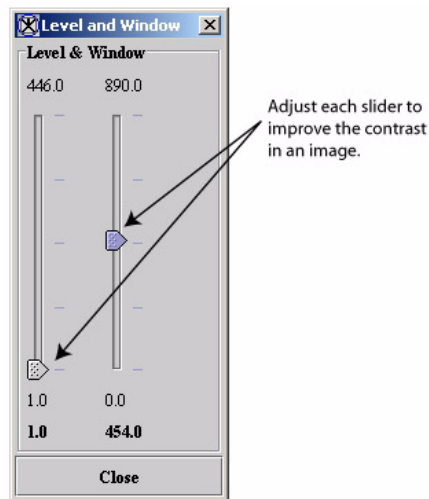
Figure 28. Level & Window dialog box

3 Move each slider up or down to change the contrast of the image. The changes are immediately effective in the image.

4 Click Close when you are finished.

Restoring images to their original appearance

To return to the original appearance of the image, click Reset LUT ▣, which is also located on the image toolbar. In addition, you can click the Gray icon ▣ to restore the image to grayscale if you have changed or added colors.

Improving contrast by generating and modifying histograms

A *histogram* is a graphic representation of the intensity level distribution in an image or VOI region. It displays the number of voxels at each intensity level. To generate a histogram of an image, you can use the Lookup Table

icon 📊 on the image toolbar or the LUT menu in the MIPAV window. To obtain a histogram summary, which is in tabular form, use the Histogram Summary command on the Utilities menu (refer to "Creating a histogram summary" on page 390).
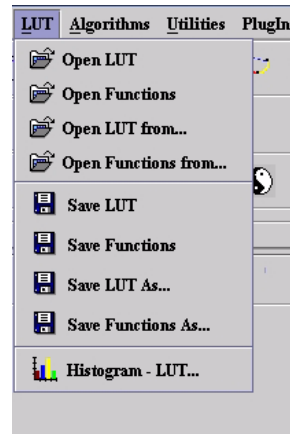
Figure 29. LUT menu in the MIPAV window

To generate a histogram for an image

1 Open an image. The image appears in an image window.

2 Do either of the following:

- Click Lookup Table icon 📊.

- Select LUT > Histogram - LUT.

The Histogram dialog box (Figure 30) appears.

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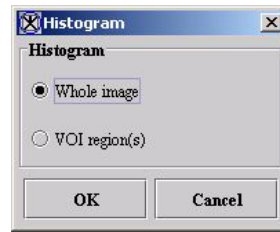
Figure 30. Histogram dialog box

3 Select either Whole image or VOI region(s).

4 Click OK. A progress message (Figure 31) appears.
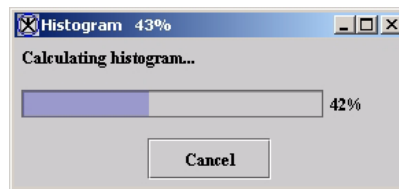
Figure 31. Progress message that appears when the program is calculating the histogram

After a few moments, the Lookup Table window (Figure 32) opens.

lookup table (LUT)—Indicates the intensity of each voxel in the image and, in MIPAV, allows you to remap the original intensities to other intensities.

transfer function—Reflects the relationship between the original image intensity values and how they are mapped into the LUT. The line in the LUT represents the transfer function.
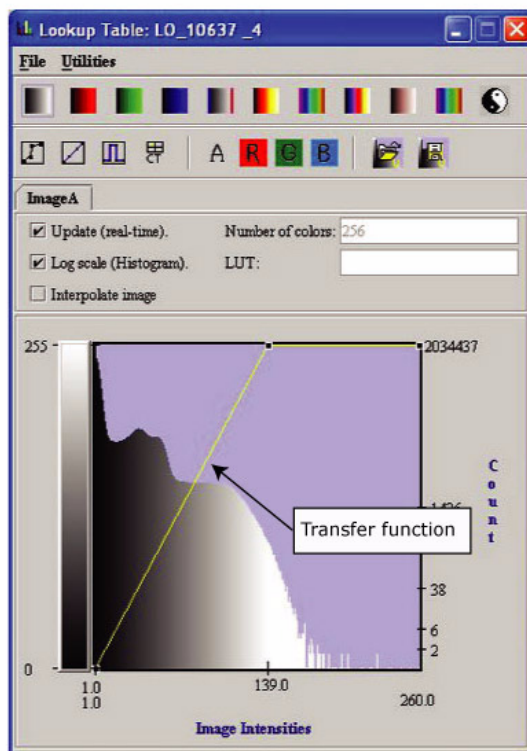
File	*Open LUT*—Opens a previously saved LUT file. LUT files have an *.LUT* extension.
	Save LUT—Saves the LUT displayed in this window in a LUT file.
	Open Transfer Functions—Opens a previously saved transfer function. Transfer function files have a *.FUN* extension.
	Save Transfer Functions—Saves the transfer function displayed in this window to a file.
	Close LUT—Closes the LUT window.

Figure 32. Lookup Table window

Utilities	*Change number of colors*—Allows you to change the number of colors displayed in the image. Valid values are 2 to 256.
	CT function—Allows you to select a preset LUT that is appropriate for the image content. Values are abdomen, head, lung, mediastinum, spine, and vertebrae.
	Invert LUT—Creates a negative of the image.
	Reset histogram and LUT A—Returns image A to its original values.
	Reset histogram and LUT B—Returns image B to its original values. This command is only available if two images are open.
LUT toolbar	See Figure 33.
Update (real-time)	Changes the image as you make changes to the LUT, which allows you to see the effect of your changes immediately on the image.
Log scale (histogram)	Displays the image's histogram count in log scale along the *Y* axis.
Interpolate image	Displays image using interpolation, which reduces pixilated image to appear more smooth.
	Caution: Depending on the memory resources of your workstation, interpolation can be very lengthy.
Number of colors	Allows you to change the number of colors displayed in the image.
LUT	Displays the image intensities.

Figure 32. Lookup Table window (continued)

Applying color to images using predefined LUT

MIPAV provides a variety of pseudo-color LUTs. When a pseudo-color LUT is applied to an image, the grayscale intensities are remapped to the pseudo-color intensity values. The LUT toolbar appears in Figure 33.

> ## Using interpolation to smooth images
>
> If you are zooming in on a portion of an image and want to reduce the appearance of pixilations in the image, make sure to select the Interpolate image check box. Interpolation smooths the pixilation.

To apply a pseudo-color LUT

1 Open an image. The image appears in the image window.

2 Select the image window.

3 Select one of the LUTs on the LUT toolbar (Figure 33) in the Lookup Table window.
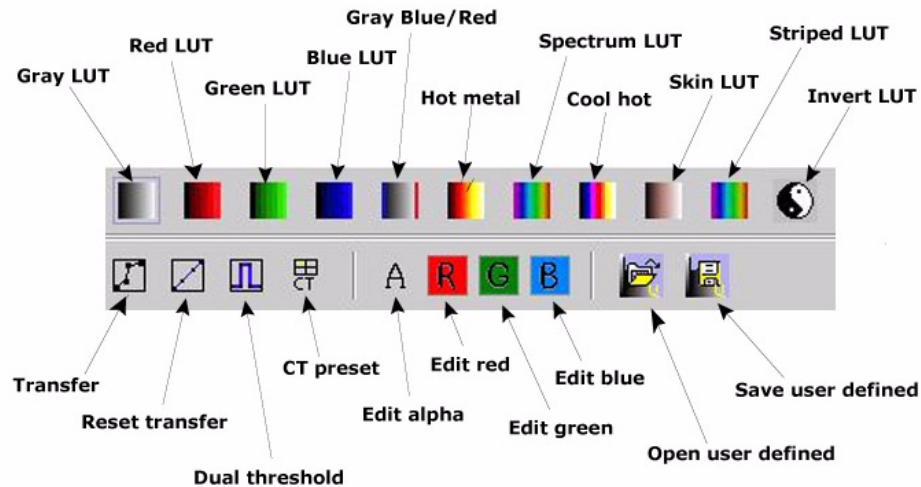
Figure 33. LUT toolbar

4 Do either of the following:
- To update the view of the image immediately, select Update (real-time).
- If you do not want to update the view of the image, click Close. The Lookup Table window closes, and MIPAV applies the LUT to the image.

Tip: To change back to the original grayscale intensities, click Gray LUT ▉ in the MIPAV window.

Creating negatives of images

The invert LUT icon creates a negative of an image.

To create a negative image

1 Select the image window of the image you want to invert.

Tip: You may wish to apply an LUT to the image or adjust the histogram of the image first before applying creating the negative.

2 Click Invert LUT ⬤ .

Note: Invert LUT ⬤ appears on two different windows: in the Image toolbar in the MIPAV window (select Toolbars > Image toolbar to display the toolbar) and in the LUT toolbar in the Lookup Table window.

Based on the 256-step color values scale, MIPAV assigns the inverse value to each pixel (refer to Figure 34).

(A) Before inversion   (B) After inversion
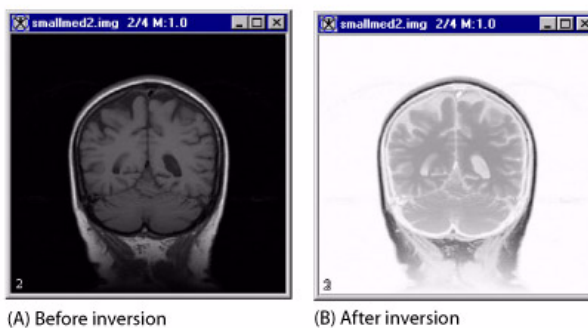
Figure 34. Image before and after inversion

Tip: The Invert LUT icon ⬤ is a toggle. To change the image back to its previous appearance, simply select Invert LUT ⬤ again. To change the image back to its *original* appearance, select Reset LUT 🔲 .

Comparing images using alphablending

Alphablending is a technique that adds transparency information to translucent objects. When two images share a window, you can adjust the alphablending settings so that you can see a blend of both images and can compare overlapping regions in two datasets.

To use the alphablending function

1 Select an image window that has two images.

2 Adjust the alphablending slider at the bottom of the MIPAV window.

3 Move the slider to select the best ratio for the datasets of interest.

The level of translucency for one image is inversely proportional to the other. Thus, if image A is 75 percent transparent (25 percent opaque), then image B is 75 percent opaque (25 percent transparent).
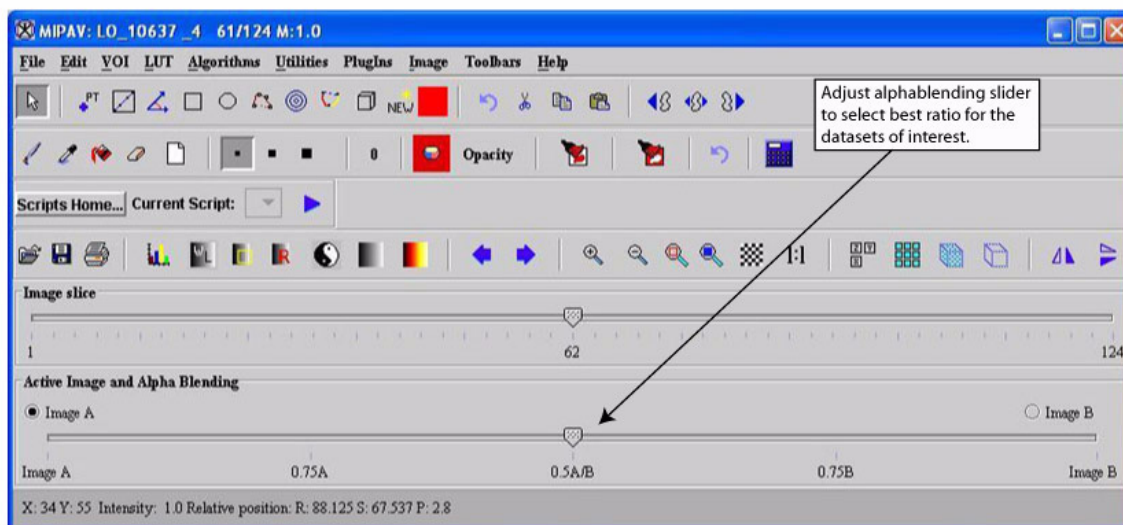
Figure 35. MIPAV window showing the alphablending slider at the bottom of the window

Creating new images

To create a new image file

1 Do one of the following:

- If an image file is not already open, select File > Create Blank Image(B).

- If an image file is already open, select File > Open > Create Blank Image(A).

    The Raw dialog box (Figure 36) appears.

2 Select the image type.

3 Select the units of measure for each dimension.

4 Enter the header offset and byte ordering information.

Figure 36. Raw dialog box

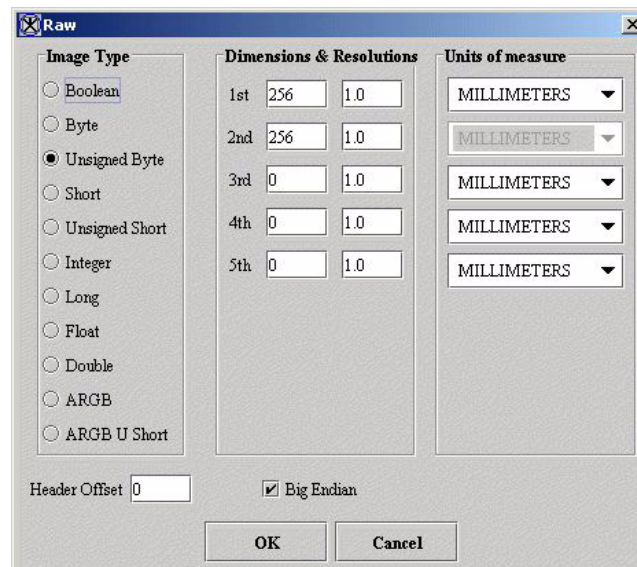|	
Image type	Synonymous with data type. The image type determines the number of intensities that can be represented in an image. For example, a Boolean image can display two intensities: 1 and 0. • *Boolean*—1 bit per pixel (1 on, 0 off) • *Unsigned byte*—1 byte per pixel (0, 255) • *Unsigned short*—2 bytes per pixel (0, 65535) • *Unsigned integer*—4 bytes per pixel (0, 2^{32} -1) • *Float*—4 bytes per pixel (-3.4E38, 3.4E38) • *ARGB*—3 bytes per pixel, plus 1 byte; 8 bits per color channel (alpha, red, green, and blue) • *Byte*—1 byte per pixel (-128, 127) • *Short*—2 bytes per pixel (-32768, 32767) • *Integer*—4 bytes per pixel (-2^{31}, 2^{31}-1) • *Long*—8 bytes per pixel (-9.22E18, 9.22E18) • *Double*—8 bytes per pixel (-1.8E308, 1.8E308) • *ARGB U short*—2 bytes per color channel and 2 bytes for alpha channel
Dimensions and resolutions	Degree of manifoldness of a quantity such as space or time. Two-dimensional datasets are composed of one image (the two dimensions are length and width). Generally, three-dimensional datasets are composed of more than one image. The third dimension is generally space. The fourth dimension is generally time. (Either time or space can be the third or fourth dimensions.) Zeros in the text boxes indicate that the dimension is not represented in the image. For example, if the text boxes for the first and second dimensions are filled, and the rest of the text boxes are filled with a zero, the image only has two dimensions. *Dimensions* • *1st*—Width (along *x* axis) • *2nd*—Length (along *y* axis) • *3rd*—Depth (along *z* axis) • *4th*—Time (along *t* axis) • *5th*—Fifth dimension *Resolutions* Size of pixel or voxel per dimensions 1 through 5.
Units of measure	Indicates the unit of measurement for each of the applicable dimensions.
Header offset	Indicates the size of the space reserved at the beginning of the file where specific types of information is kept. This space, which is called the *header,* precedes the image data. If you know the length of the header, type it in this box. When MIPAV accesses the file, it skips the header offset and begins to read the image data. Note that not all image file formats have a header.

Figure 36. Raw dialog box (continued)

Big endian	Indicates whether image data is stored in the big endian format. If not, the image data is stored in the little endian format. *Endianness* refers to the byte ordering of the data. Some computers order the data with the least significant byte (LSB) first followed by the most significant byte (MSB). This byte order is referred as *little endian* or Intel byte ordering. Machines that use little-endian byte ordering are VAXes, Intel x86, and Pentium. The reverse is MSB and then LSB, which is referred as *big endian* or Motorola byte ordering. Machines that use big-endian byte ordering are IBM System 3D, RISC, and a Motorola 680x0. MIPAV is biendian; it supports both big- and little-endian byte-ordering formats.
OK	Applies the parameters that you specified and creates a blank image.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not create a blank image.
Help	Displays online help for this dialog box.

Figure 36. Raw dialog box (continued)

5 Click OK. A blank image (Figure 37) appears in an image window.

6 Use the paint and VOI tools to create an image.
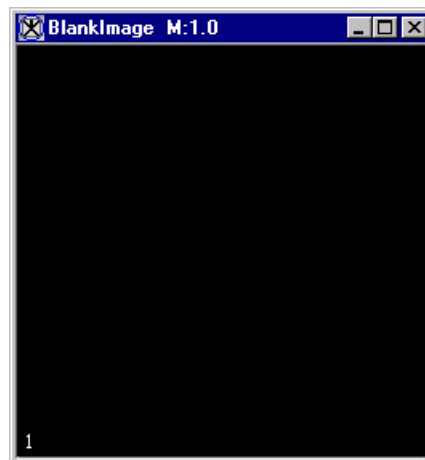
Figure 37. Blank image

7 Click File > Save image as. The Save dialog box opens.

8 Type the name of the file in File Name, and select the file type in Files of type.

9 Click OK. MIPAV saves the image under the file type you selected.

Delineating volumes of interest (VOIs)

MIPAV provides tools that allow you to automatically, semiautomatically, and manually identify and modify volumes of interest (VOIs).

volume of interest—The portion of the image in the dataset on which you want to focus. It may be either one slice or multiple slices throughout the dataset.

Each VOI can be formed from multiple contours in a single slice or multiple slices. Once an object is segmented and defined by a VOI, statistics of the volume can be calculated.

MIPAV supports over 32,000 unique VOIs on a single dataset. Additionally, you can move or delete nodes on the VOI and add new points. VOI types include:

- Point, which is created by using
- 2D line
- Rectangular
- 3D rectangular
- 2D elliptical
- Polygonal
- 3D polygonal
- Interactive level-set

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Generating contour VOIs using predefined shapes

MIPAV includes icons of predefined shapes, such as points, lines, ellipses, or rectangles, that you can use to create VOIs. These icons are on the VOI toolbar.

To generate contour VOIs using the predefined shapes

1 Select one of the contour icons from the VOI toolbar in the expanded MIPAV window (Figure 38).
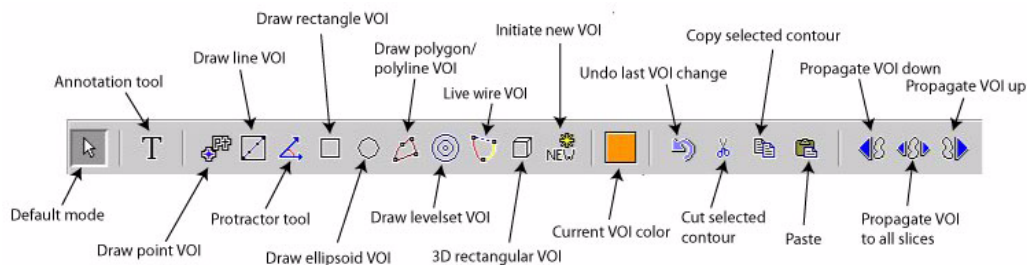
Figure 38. Contour icons on the VOI toolbar

2 Move the pointer to the image window. The pointer changes to a crosshair shape. Do one of the following:

• **Points, levelset:** Position the cursor on the area where the point or levelset should be drawn. Click the mouse button.

• **Straight lines, rectangles (2D and 3D), ellipsoids:** Position the cursor on the area where the contour should begin.

Click the mouse button.

While holding down the mouse button, drag the cursor until the contour is the desired size.

• **Polylines, polygons:** Position the cursor over the area where the contour should begin.

Click the mouse button. A point appears.

Alternate between moving the mouse and selecting the mouse button to outline the VOI.

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To complete a polyline, double-click the mouse button. To complete a polygon, connect the first and last nodes.

Tip: To draw the same shape several times in succession, hold down the Shift key while you select the applicable icon from the VOI toolbar and draw.

Adding and moving boundary points on VOIs

No matter which method you choose to delineate a VOI, you can add points and change the boundaries of the VOI. For example, suppose you created a

VOI on an image with the Rectangle VOI icon ⬜ . If you notice that a part of the image that should be included in the VOI isn't, the boundary of the rectangle needs to be adjusted to include the missing portion of the image.

To add a point and change the boundary of the VOI

1 Select the VOI. Notice that white points appear at the corners of the VOI and a small cross appears in the middle of the VOI.

2 Place the cursor on the portion of the VOI you want to adjust. The cursor changes from a cross ＋ to 🖑 .

3 Click once. A white point appears on the line.

4 Select the point and drag it to include the missing part of the image.

Tip: Circular VOIs are composed of a continuous series of points around the diameter of the circle. You only need to select one of those points and drag it to enlarge the circle.

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(A) A rectangular VOI, or a contour VOI. The cursor indicates that you can adjust the contour boundaries.

(B) The VOI after it was selected. Note the highlighted points at the corners of the VOI.

(C) The cursor changes to a hand when it's near one of the boundaries of the VOI. To add a point, slick the left mouse button on a boundary.

The point was added to the right boundary of the VOI.

(D) The point is highlighted in white.

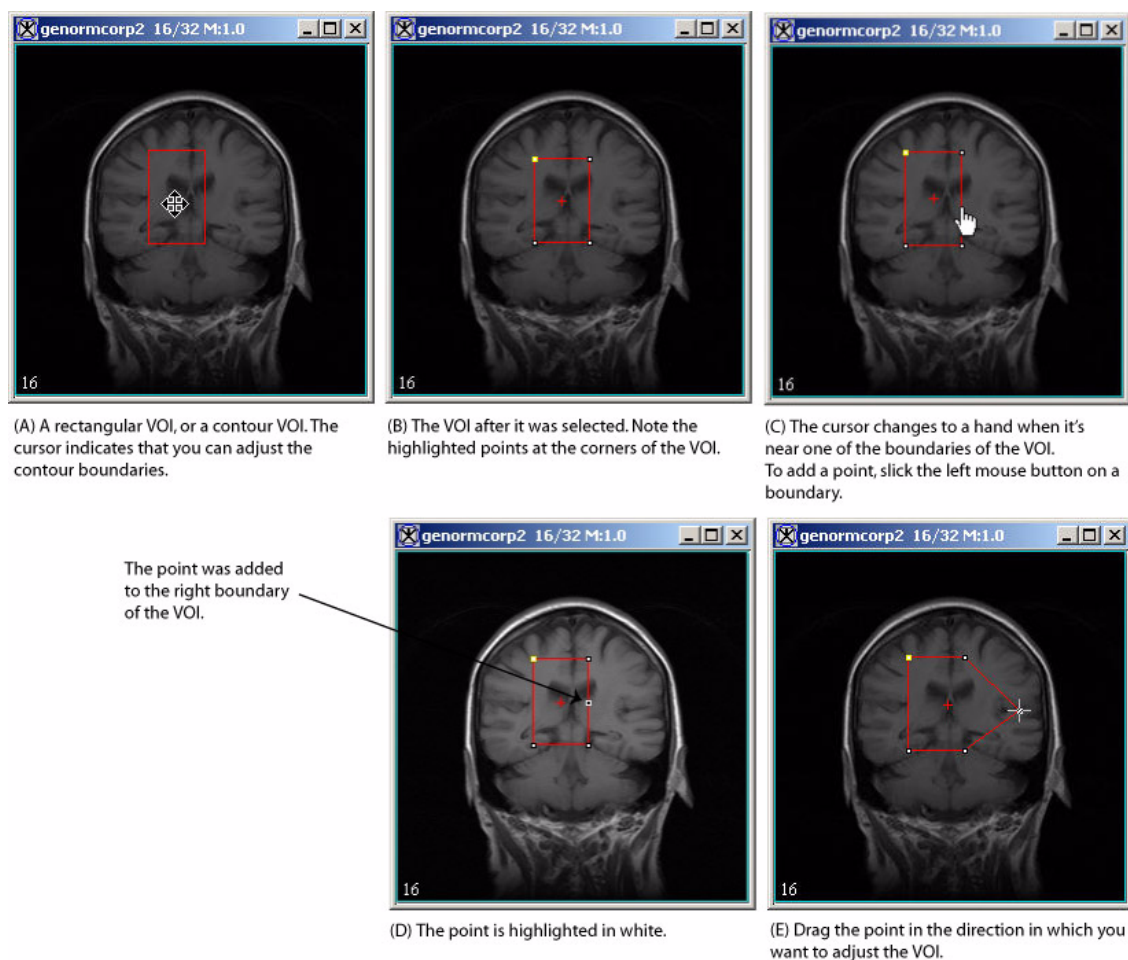(E) Drag the point in the direction in which you want to adjust the VOI.

Figure 39. Adding a point and adjusting the boundary of a rectangular VOI

Automatically adjusting contour boundaries

After a contour is drawn, it might be necessary to adjust the boundaries so it more closely matches the VOI region.

To adjust contours

1 Click a contour. The nodes become visible.

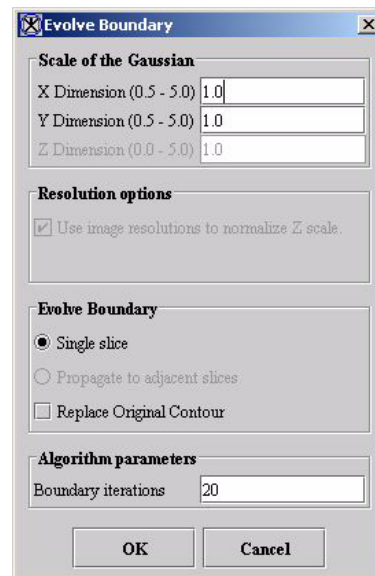2 Select VOI > Evolve boundary 2D >Active contour. The Evolve Boundary dialog box opens (Figure 40).

Figure 40. Evolve Boundary dialog box

3 Modify the information in the window if necessary.

4 Click OK.

A new contour, that more closely outlines the VOI, appears on the image. The old contour also remains.

Tip: To delete the old contour, select it and select Cut Selected Contour ✄, or press the Del key on the keyboard.

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Annotating images with text

Another icon on the VOI toolbar is the Annotation tool icon, T , which you can use to place text directly on an image at any position on the image. You can use any font family, or typeface, that is installed on your computer to display the text.

To annotate images with text

1 Open an image.

2 Click T , the Annotation tool icon. The Annotation dialog box opens.

3 Click the image on which you want the text to appear. The image becomes the active image.
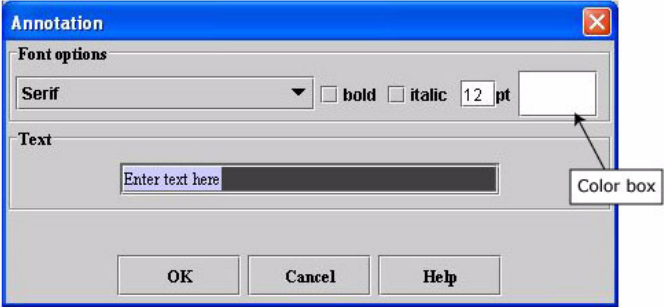
Font options	**Font**—Specifies the font family, or typeface, for the text. When you select another typeface, "Enter text here" appears in that typeface.	
	Bold—Specifies that the type style should be bold.	
	Italic—Specifies that the type style should be italic.	
	Pt (point) size—Specifies the point size of the typeface.	
	Color—Specifies the color of the text. When you click this box, the Pick VOI Color dialog box opens.	
Text	Displays the text that should appear on the image.	
OK	Applies the parameters that you specified and places the text on the image, which you can move to any position on the image.	
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not place text on the image.	
Help	Displays online help for this dialog box.	

Figure 41. Annotation dialog box

4 Select the font family and style (bold or italic).

> **Tip:** To select a regular font style, simply specify the font family.

5 Type the size of type in the pt box.

6 Press Enter. The Annotation dialog box either enlarges or reduces in size depending on the type size you chose (see "Previewing Font Selection" below).

7 Click Color to select the color of the text. The color of the type in the Text box changes to the color you chose.

8 Select "Enter text here" and type the text that you want to display on the image in the Text box.

9 Click OK. The text appears near the top of the image.

10 Click the text and drag it to any position on the image (Figure 42).

Previewing Font Selection

The Annotation dialog box allows you to preview the font family, style, typesize, and color of the text before you click OK and add the text to the image.
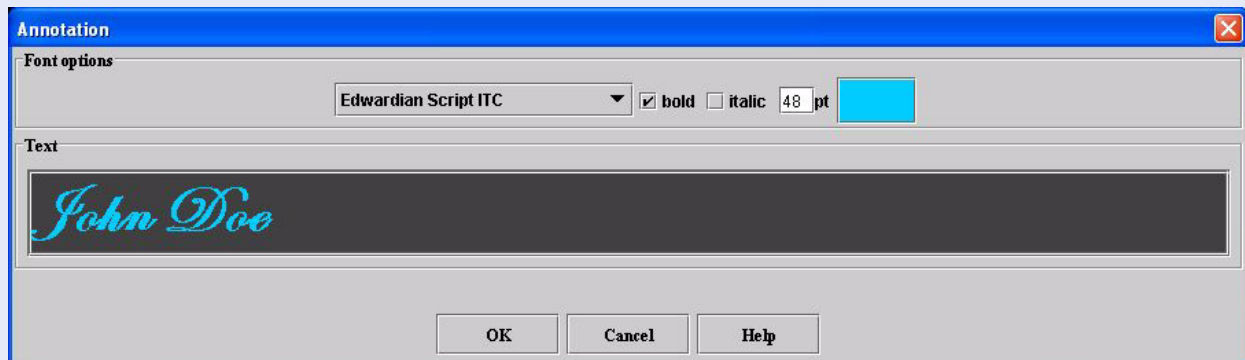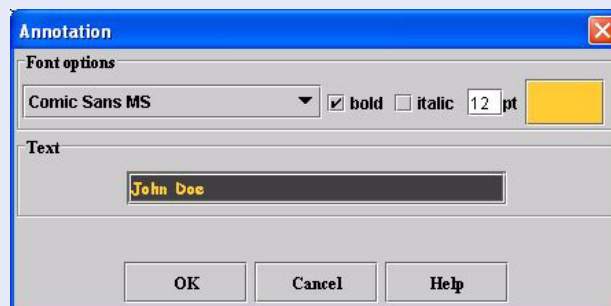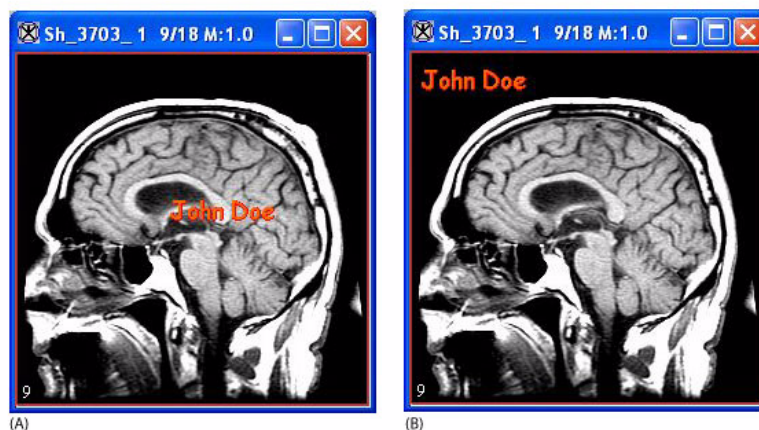
Figure 42. An annotated image: (A) text in its default position on the image and (B) text moved to another position

To edit the text

1 Double-click the added text on an image. The Annotation dialog box opens.

2 Make any changes you want to the text, font family, font style, and color.

3 Click OK. The changes you made to the text should appear on the image.

To delete the text

1 Select the added text on an image.

2 Press Del. MIPAV removes the text from the image.

Note: To restore the text to the image, select Edit > Undo VOI. The text reappears on the image.
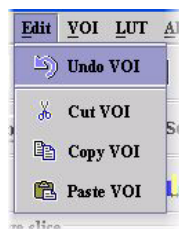
Calculating VOI statistics

Once a VOI is drawn, you can calculate the number of voxels in the VOI, the volume, and area. You can also calculate the average and standard deviation of the voxel intensity and the center of mass. For 2D images, you can calculate the principal axis and the eccentricity.

MIPAV provides two methods for you to obtain VOI statistics:

- *By using VOI properties*—This method is fast and simple and provides statistics for the entire VOI. Although it allows you to save the results in a text file, that is an additional step. However, using this method, you can type additional information directly onto the Data page with the statistics.

- *By using the Statistics Generator*—Using this method, you can obtain statistics on the entire VOI, on a single slice of the VOI, or by contour and slice. The Statistics Generator also automatically saves the results in either a tab-delimited file or an XML file of your choosing. In addition, it displays statistics in a tabular format.

Note: MIPAV can calculate statistics for only one VOI at a time. In addition, MIPAV calculates the volume and area in a VOI using image pixel (voxel) resolutions.

Using VOI properties

To calculate VOI statistics

1 Delineate a VOI on an image.

2 Select the desired VOI in the image window.

3 Select VOI > Properties in the MIPAV window. The VOI Statistics dialog box appears (Figure 43).

4 Select the statistics to be calculated in Statistics to Calculate.

5 Click Calculate.

6 Select the statistics to be calculated in Statistics to Calculate.

7 Click Calculate.

The VOI Statistics dialog box remains on the desktop. In a few moments, statistical data appears on the Data page in the Output window.

Figure 43. VOI Statistics dialog box
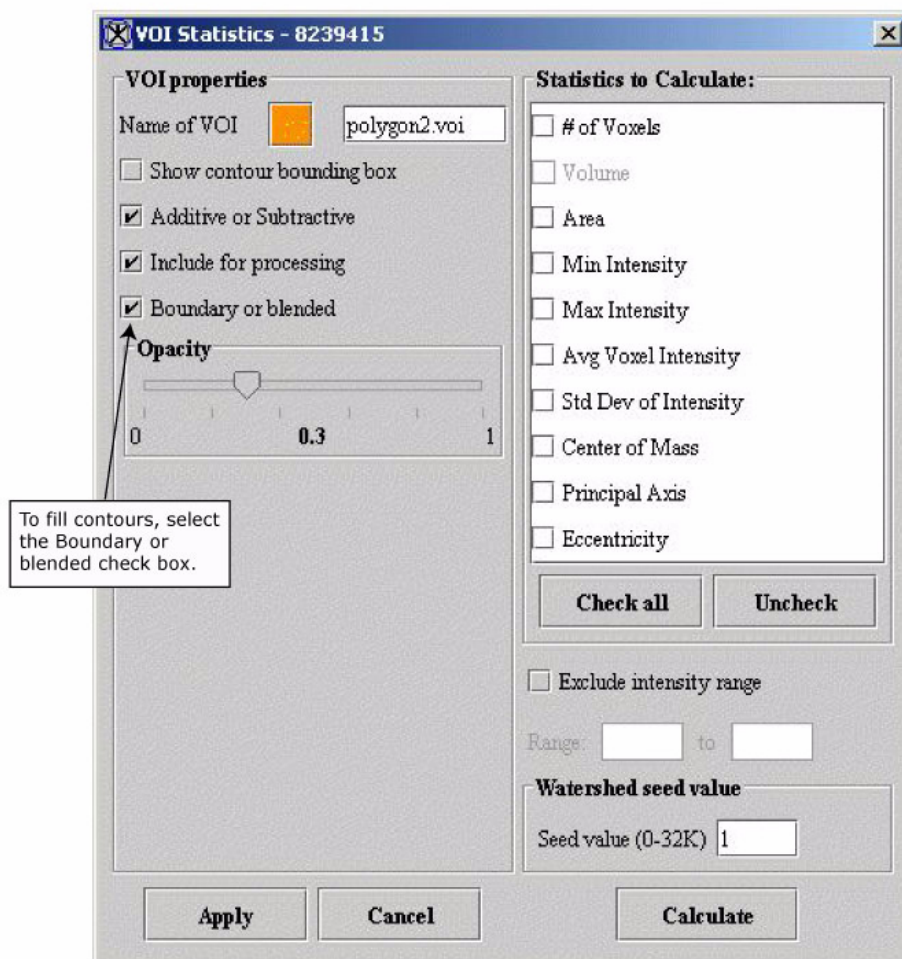
Name of VOI	Shows the name of the VOI.
Show contour bounding box	Highlights the VOI and, when you select the VOI, displays a box that encompasses all of the VOI's borders and lists the measurements and position of each boundary.
Additive or subtractive	Not implemented at this time.
Include for processing	Not implemented at this time.

Boundary or blended	Smooths the image inside the VOI.
Statistics to calculate	Provides a list of statistics. Select the statistics that you want to include in the report.
Select all	Selects all of the statistics listed in the Statistics to calculate list.
Clear	Clears all of the check boxes that you selected in the Statistics to calculate list.
Exclude intensity range	Allows you to select specific intensity ranges in the Range boxes that you want to exclude from the calculation.
Watershed seed value (0-32K)	Indicates the basin value used when running the Watershed algorithm on images.
Apply	Applies the changes you made in this dialog box and leaves the dialog box open for you to make further changes.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not run a statistics report.
Calculate	Calculates the statistics requested in this dialog box and displays them in the Data page of the Output window.

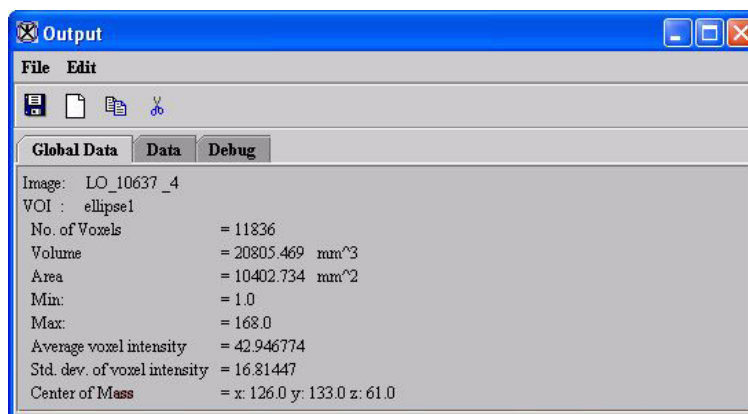**Figure 43. VOI Statistics dialog box (continued)**

Figure 44. Output window showing statistics

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8 Click the Data tab in the Output window to view the results. The Data page in the Output window (Figure 44) appears.

9 Do one or a combination of the following if desired:

- Add information to the statistics by typing the information directly into the statistics on the Data page.

- Select the data that you want to remove, and then click Cut ✂ or select Edit > Cut (Figure 45) to cut the selected data. MIPAV removes the selected text from the Output window and copies it to the clipboard for use in other applications.
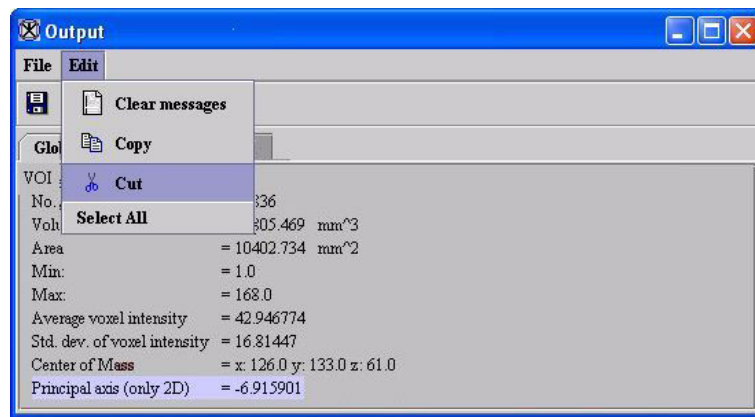
Figure 45. Edit menu on the Output window

- Select the data that you want to copy, and then click Copy 📋 or select Edit > Copy to copy the data to another location in the window or to another application (such as a word-processing program).

- Click Save 💾 or select File > Save (Figure 46) messages (Figure 46) to save the data and any comments you've added to a text file.

- Click Clear Messages 🗋 or select Edit > Clear Messages to clear the window.

10 Click Cancel in the VOI Statistics dialog box when complete to close the dialog box.
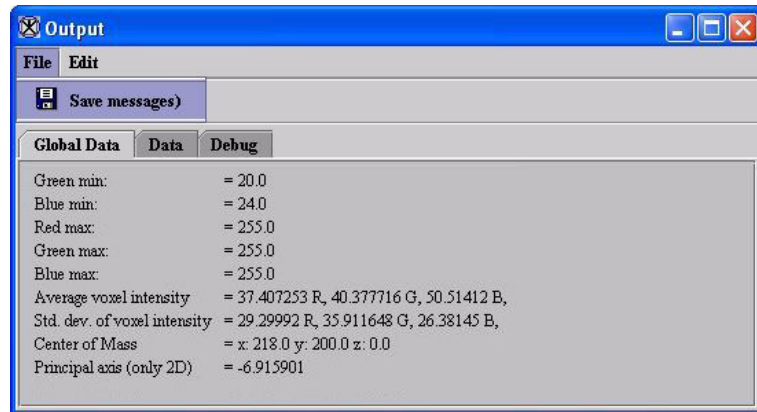
Figure 46. Save messages command on File menu in the Output window

Using the Statistics Generator

If you plan either to use a database or spreadsheet to keep track of VOI statistics or to obtain them in an XML format, use the Statistics Generator. As mentioned earlier, the Statistics Generator can provide statistics on an entire VOI or a particular slice or by contour and slice.

Using the Statistics Generator includes three tasks:

- Selecting VOI and save options
- Selecting statistics options
- Reviewing the statistics

SELECTING VOI AND SAVE OPTIONS

The first task is to select the VOIs on which you want to obtain statistics and select the file in which the resulting statistics should be saved.

To select VOIs

1 Delineate a VOI on an image.

2 Select the VOI in the image window.

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3 Select VOI > Statistics Generator in the MIPAV window. The Calculate Statistics on VOI Groups window appears (Figure 47).

This window displays all of the VOIs on the image in the VOI group list on the left.
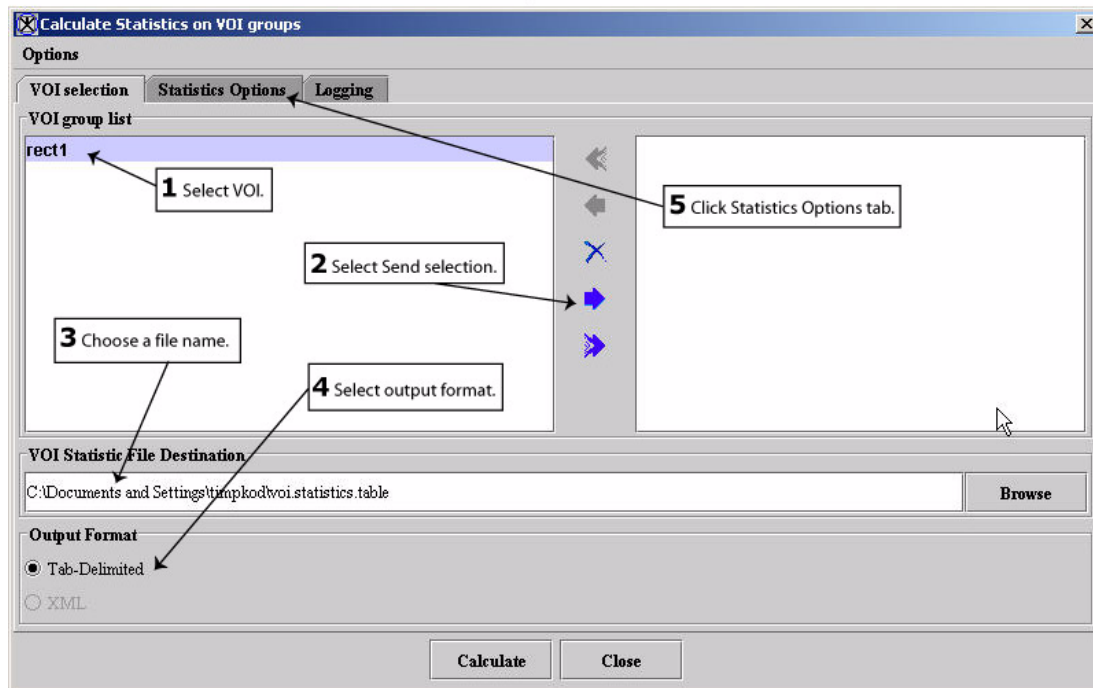
Figure 47. Calculate Statistics on VOI Groups window

4 Select the VOI on which you want to obtain statistics in the VOI group list.

5 Select Send selection right ➡. The name of the VOI appears in the VOI group list on the right.

6 Use Browse to choose a file name in the VOI Statistic File Destination box.

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7 Select either of the two formats in the Output Format group:

- Tab delimited
- XML

8 Click Statistics Options. The Statistics Options page opens.

9 Proceed to the next task: Selecting statistics options.

SELECTING STATISTICS OPTIONS

The Statistics Options page (Figure 48) provides a list of statistics from which you can select and the options to obtain statistics by slice, by contour and slice, or by the total VOI.

To select statistics to perform on VOIs

1 Do either of the following in the Statistics to calculate group:

- Select one or more of the listed types of statistics.
- Click Select all to obtain all of the statistic types.

2 Select one of the following options in the Statistics options group:

- By contour & slice
- By slice only
- By total VOI (the default selection)

3 Select Show all totals if you want to record the totals for each type of statistic.

4 Click Calculate.

5 Select Logging. The Logging page (Figure 49) appears.

6 Proceed to the next task: "Reviewing the statistics".
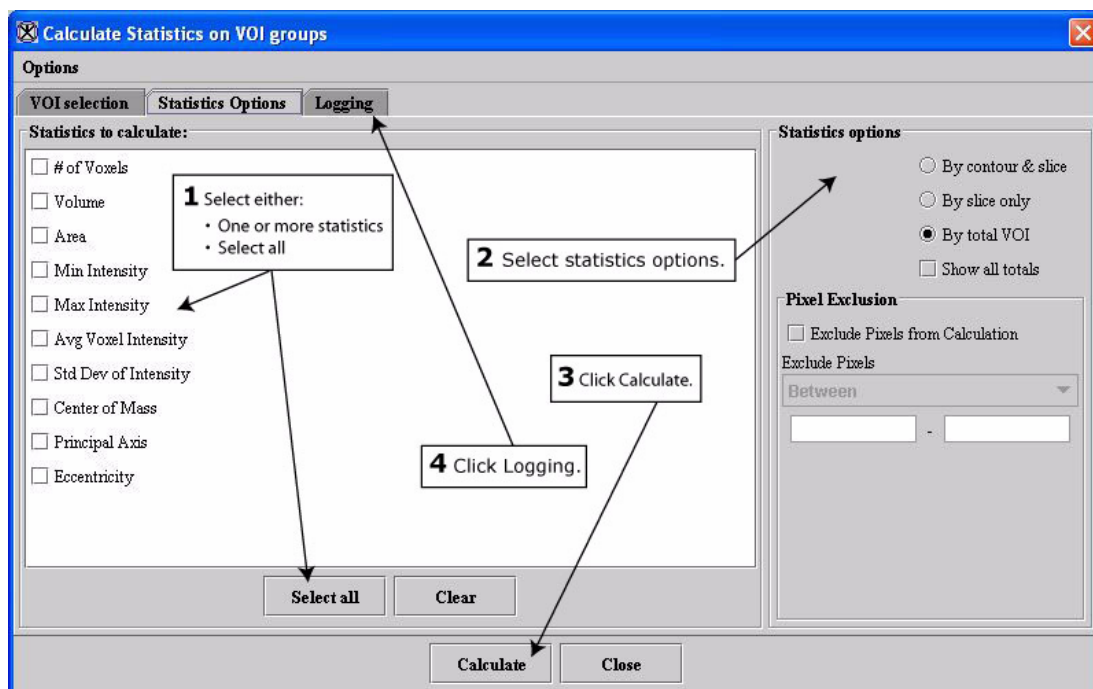
Figure 48. Statistics Options page

Overwriting statistics files

If you previously ran the Statistics Generator and obtained statistics, after you click Calculate a message appears stating that a statistics file already exists. It asks whether to overwrite the file or to cancel the action.
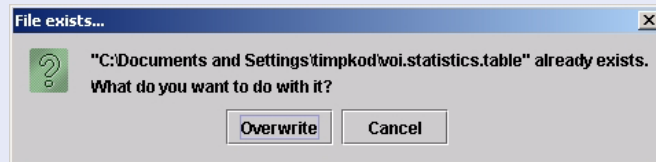
If you not want to overwrite the file, click Cancel. The following warning message appears.

Return to the VOI selection page and choose another file name in the VOI statistic file destination box. Then click Calculate to obtain the new set of statistics. The Statistics Generator calculates the statistics and saves them in the file that you indicated. The statistics appear on the Logging page.

If it's all right to overwrite the file, click Overwrite. The Statistics Generator calculates the statistics and overwrites the previously recorded statistics file.

Tip: If you always want the Statistics Generator to overwrite the file, either select Options > Overwrite file automatically or press Alt O.
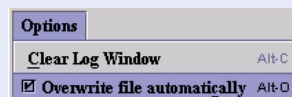
Go to the next task: "Reviewing the statistics".

REVIEWING THE STATISTICS

The Logging page (Figure 49) displays the statistics in tabular form. Whether or not you chose a type of statistic on the Statistics Options page,

the table includes a heading for each type. Blanks cells in the table indicate that you did not choose to obtain that particular type of statistics.

Each time you calculate the statistics for a VOI the Statistics Generator adds another row of statistics to the table. Note that the first column in the table lists the name of the VOI and, if appropriate, the slice and contour numbers. Also, you can change the width of each of the columns in the table by dragging the line between the columns in the heading.
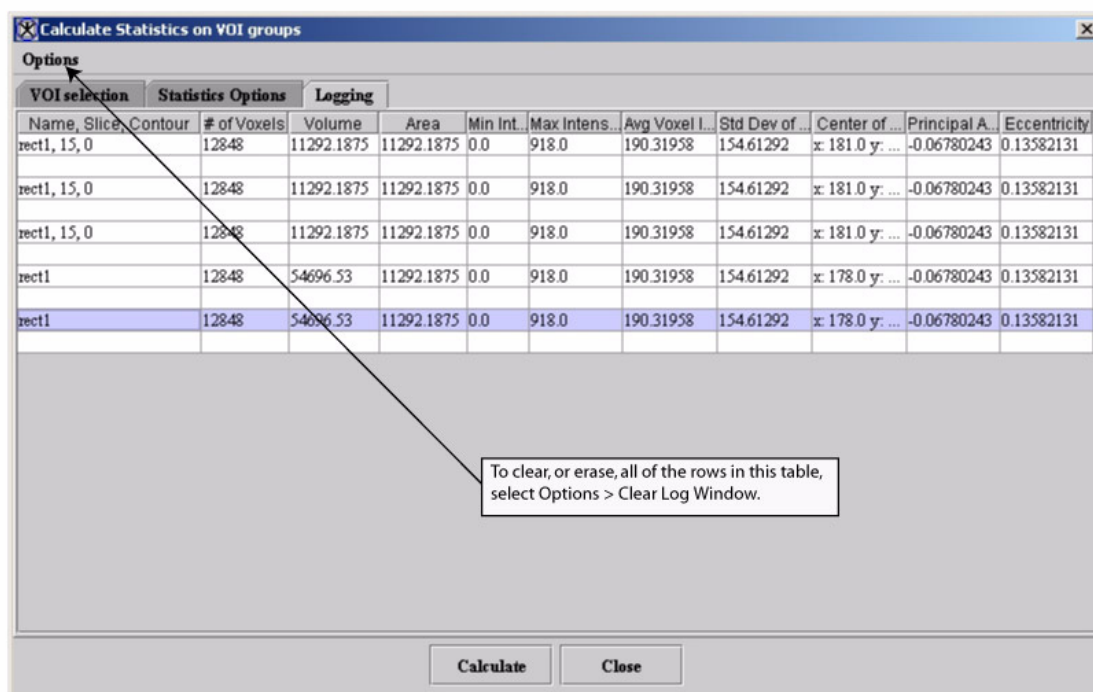
Figure 49. The Logging page in the Calculate Statistics on VOI Groups window

You can include and review the statistics file in a database or in a spreadsheet program by double-clicking on the file name in Windows Explorer window and, in the Open with dialog box, selecting the application in which you want to open the file.

When the number of rows in the table exceeds the length of the Logging page, scroll bars appear on the right side of the table to allow you to scroll from the beginning or to the end of the table.

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If at any time you want to clear, or erase, all of the rows of the table, select Options > Clear log window (Figure 50). The complete table disappears from the Logging page, which is now totally gray.

Figure 50. Options menu showing the Clear Log Window command

Modifying image resolutions

To modify the resolutions in an image

1 Open an image.

2 Select Image > Attributes > Edit attributes in the MIPAV window. The Image Attributes dialog box (Figure 51) opens.

3 Click Resolutions. The Resolution page (Figure 52) appears.
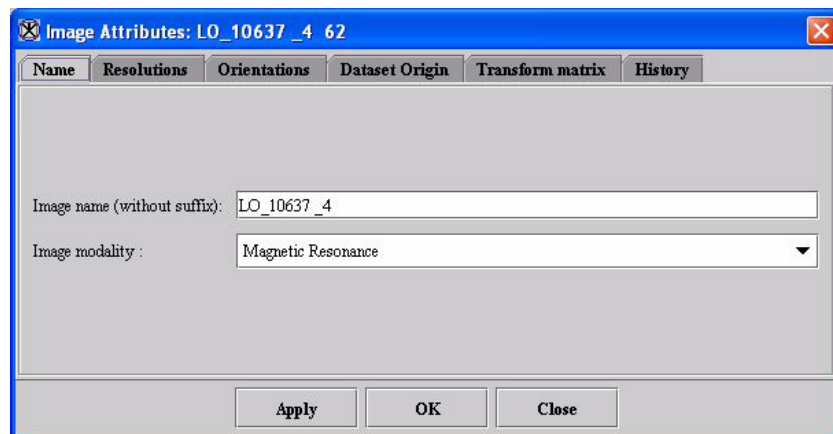
Figure 51. Image Attributions dialog box

4 Modify the resolutions.
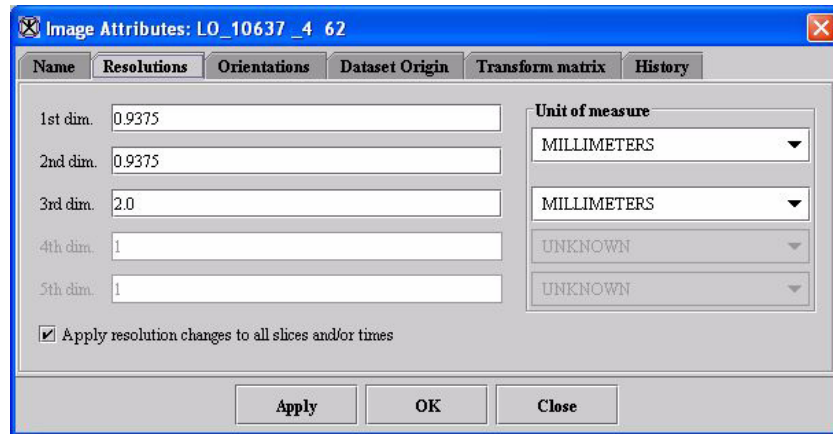
Figure 52. Resolutions page in the Image Attributes dialog box

5 Click Apply.

6 Click OK or Close when complete. The window closes.

Generating graphs (intensity profiles)

MIPAV can generate a graph of the intensity values of a region bound by a VOI. You can then save this graph, or *intensity profile,* to a file for future reference.

Generating new graphs

You can generate an intensity profile for any VOI.

To generate a graph of a VOI

1 Select a VOI in an image window.

2 In the MIPAV window, select one of the following:

- VOI > Graph > Boundary intensity
- VOI > Graph > 2.5D total intensity
- VOI > Graph > 2.5D average intensity

Tip: You can also select these same commands by right-clicking inside the VOI in the image window and selecting Graph and the appropriate command (Figure 53).
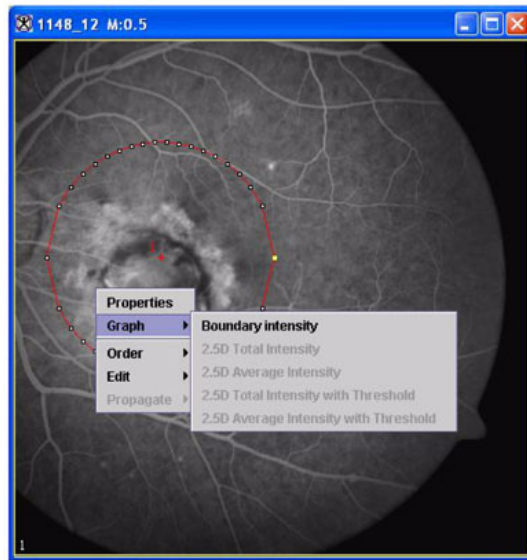
Figure 53. Right-clicking on selected VOI

Either the Contour VOI Graph window (Figure 54) or the Intensity Graph window (Figure 55) appears.

Each function on the graph represents the intensity levels within each channel.

3 Close the graph by either selecting File > Close graph or pressing Ctrl X.
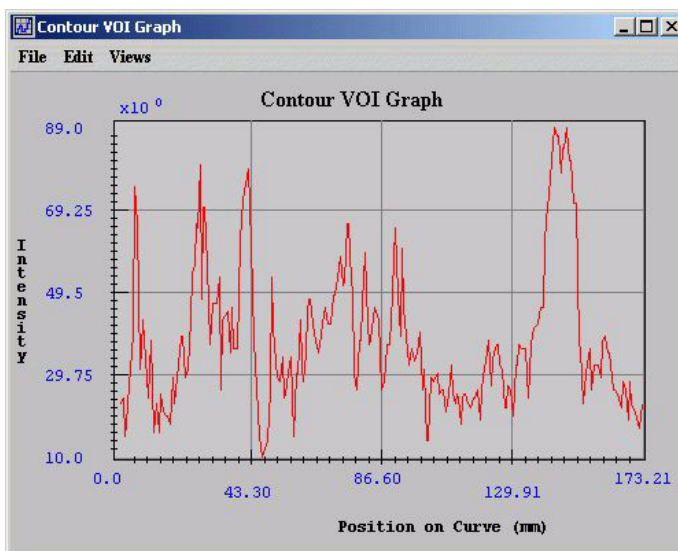
Figure 54. Contour VOI Graph window
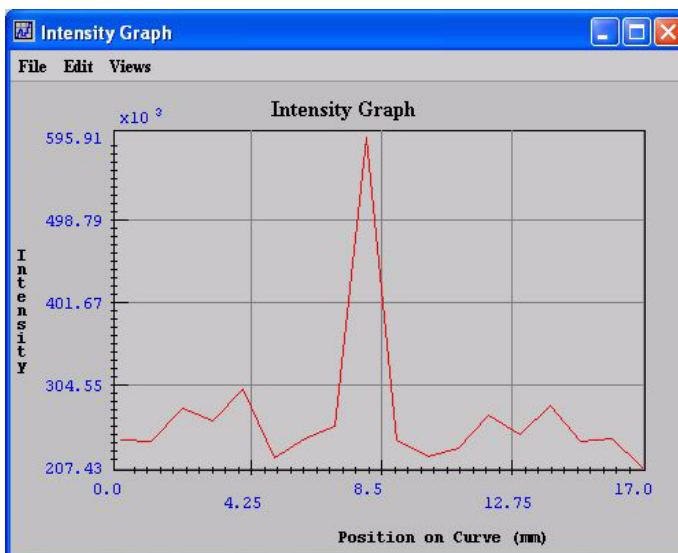
Figure 55. Intensity Graph window

Saving graphs to a file

To save a graph

1 Select File > Save graph in the Intensity Graph window (Figure 55) or the Contour VOI Graph window (Figure 55), or press Ctrl S.

The Save dialog box (Figure 56) appears.
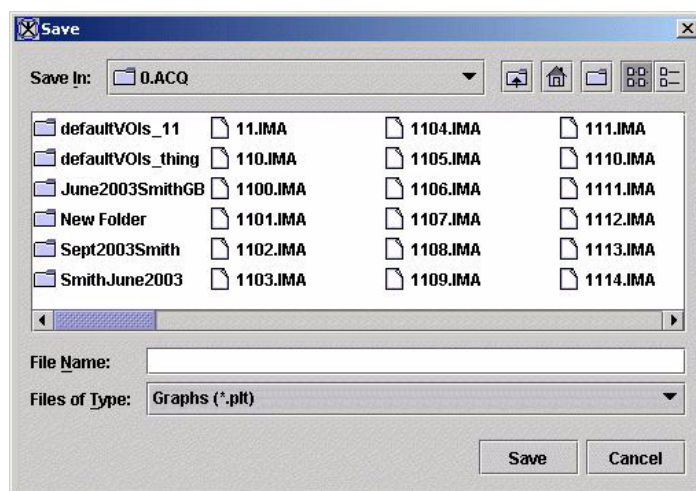
Figure 56. Save dialog box

2 Type a name for the graph in File name.

3 Make sure that Graphs (*.plt*) appears in Files of type.

4 Click Save. MIPAV saves the file under the specified name.

Printing images or graphs

To print images and graphs

1 Do one of the following:

- Click Print 🖨 in the MIPAV window.

- Select File > Print image in the MIPAV window.

- Select File > Print graph in the Graph window.

The Print dialog box (Figure 57) appears.

2 Adjust the print options if necessary.

3 Click OK to print the graph or image on your default printer.
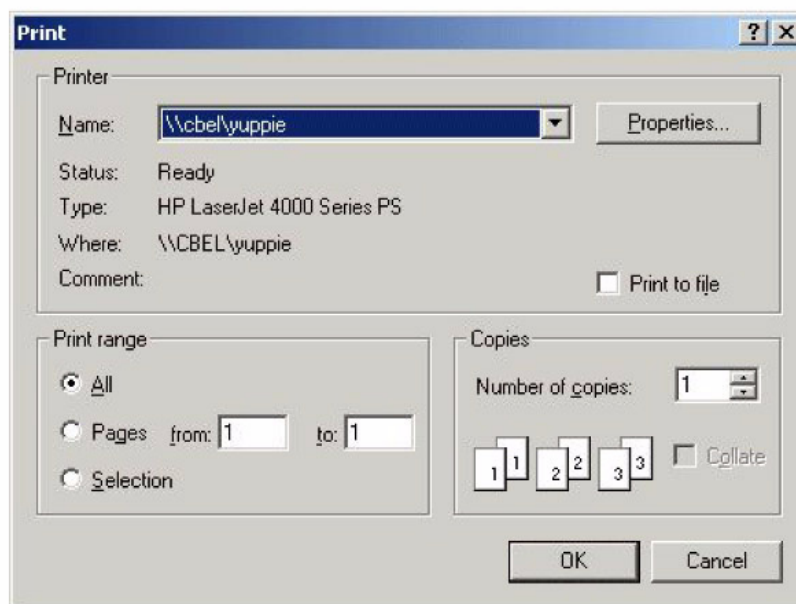
Figure 57. Print dialog box

Saving images

This section explains how to save images in the same format (as when opened) or in a different one. It also explains how to save an image as a TIFF file.

> **Note:** If you prefer for MIPAV to use the style of Open and Save dialog boxes that are used by the operating system (e.g., Microsoft Windows, Unix, or Apple) on your computer, read the section on "Using platform-specific Open and Save dialog boxes" on page 90.

Saving images in the same format

To save an image file in the same format (as when opened)

1 Do one of the following in the MIPAV window:
  - Click Save Image.
  - Select File > Save Image.

The Save dialog box appears (Figure 58).
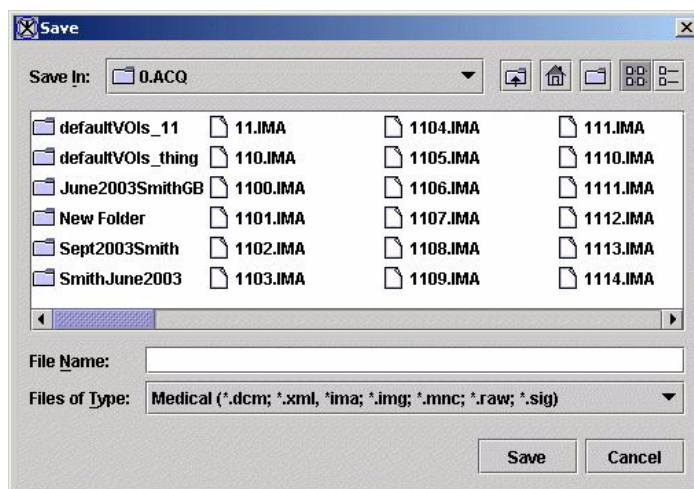
Figure 58. Save dialog box

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2 Type the name of the file in File name.

3 Click Save.

Saving images as RGB TIFF files

An image can be saved as an RGB TIFF file.

To save images as RGB TIFF files

1 Select File > Save as in the MIPAV window.

The Save Image as dialog box (Figure 59) appears.
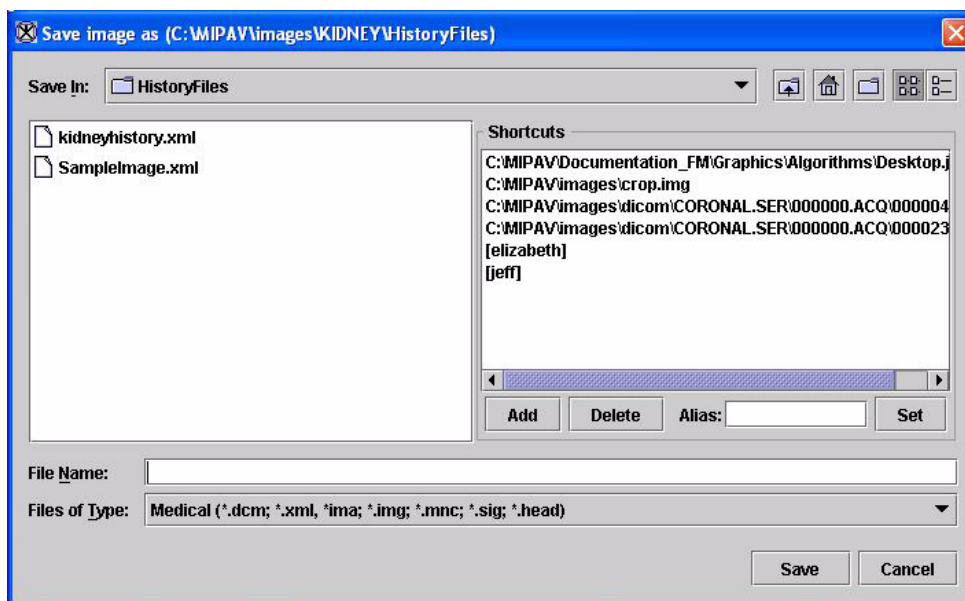
Figure 59. Save Image as dialog box

2 Type the name of the image in File name. Make sure you add *.tiff* as the extension.

3 Click Save. MIPAV saves the file as a TIFF file under the name you specified.

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Saving images to MINC format

To save images to MINC format

1 Select File > Save As.

The Save Image as dialog box (Figure 58 on page 81) appears.

2 Type the name of the file in File name. Make sure you add *.mnc* as the extension.

The Attributes to Save dialog box (Figure 60) appears.
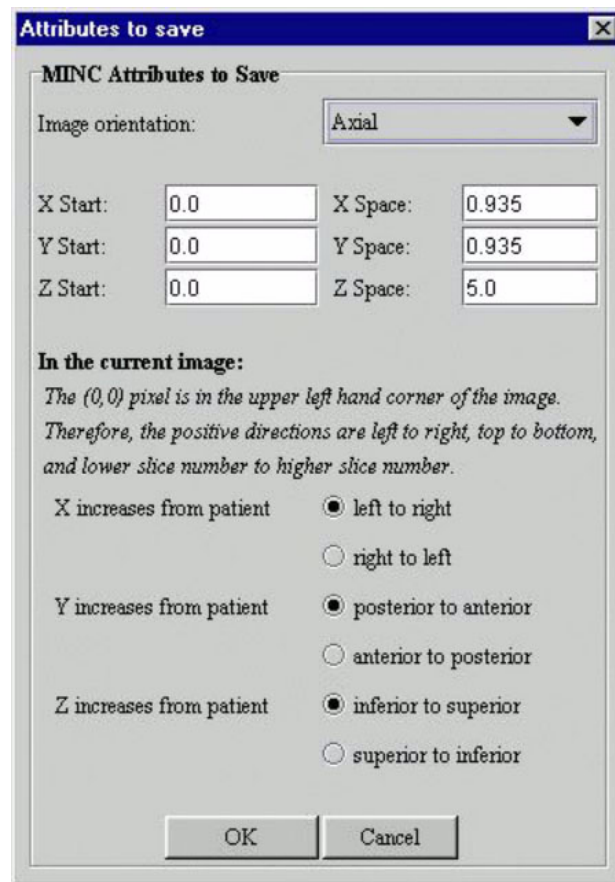
Figure 60. Attributes to Save (MINC) dialog box

Note: MIPAV uses the file extension to save image into various formats. Thus, saving an image with the extension of *.tiff* causes the image to be saved as a TIFF image. Saving an image with the extension of *.img* causes the image to be saved as an Analyze image. See Table 1 for file extensions supported by MIPAV.

3 Complete the text boxes with the appropriate information. Note that the *x, y,* and *z* values differ from DICOM.

4 Click Save. MIPAV saves the image under the name and extension you specified.
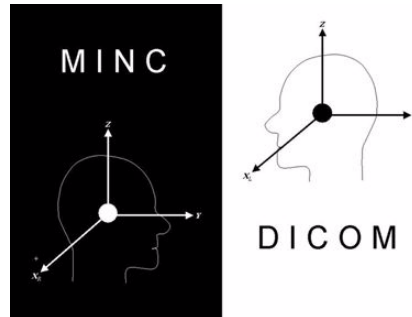
Figure 61. Comparison of MINC and DICOM image orientation

Saving images to XML format

To record a history of actions that were performed on images, you should save the images to XML format. When you save images to XML format, MIPAV creates two files for each image: a RAW file, which contains image data, and an XML file. The XML file includes image attributes, such as action history. You can view the attributes of an image by selecting Image > Attributes > Edit Attributes or by viewing the .xml file using a text editor or an internet browser.

For more information on recording a history of actions, refer to "Saving a history of actions on images" on page 99.

To save images to XML format

1 Select File > Save as.

The Save Image as dialog box (Figure 59 on page 82) opens.

2 Accept the name currently in File name or type a new name. Make sure you add *.xml* as the extension.

3 Click Save.

MIPAV saves the file under the name and extension you specified and begins, from this point on, to record a history of actions performed on the image.

Saving images to another format or renaming images

To save images to a different format from the original file

1 Select File > Save as.

The Save Image as dialog box (Figure 59 on page 82) appears.

2 Type the new name in File name. To save the file in a different format, change the file extension. A list of extensions appears in Table 1 on page 24.

3 Click Save. MIPAV saves the file under the name and extension you specified.

To rename images

1 Select File > Save as.

The Save Image as dialog (Figure 59 on page 82) appears.

2 Type the new name in File name. Either keep the extension already specified or change it to another file type. A list of extensions appears in Table 1 on page 24.

3 Click Save. MIPAV saves the file under the name and extension you specified.

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Customizing MIPAV

You can set the following MIPAV configuration options:

- Show or hide the splash screen
- Using platform-specific Open and Save dialog boxes
- Show or hide toolbars
- Place MIPAV in debug mode
- Manage memory resources
- Save a history of actions on images
- Choose the default file types to display or save
- Develop and use plug-in programs

Showing or hiding the splash screen on start-up

The *splash screen* is the window that first appears briefly when you start MIPAV. It appears immediately before the MIPAV window and the Output window open. The splash screen displays the name of the program and the MIPAV logo.

By default, MIPAV always displays the splash screen on start-up unless you decide to hide it. To do so, you need to change the option in the MIPAV Options dialog box.

To hide the splash screen or prevent it from appearing on start-up

1 Select Help > Program Options. The MIPAV Options dialog box (Figure 62) opens.

2 Clear Display Splash Screen. The check mark disappears from the check box.

3 Click Apply, and click Close. The MIPAV Options dialog box closes. The next time you start MIPAV, the splash screen does not appear.

Remember: A *cleared check box* is one that *does not contain* a check mark. A *marked check box* does contain a check mark. To clear a check box, simply click the check *box.* The check mark disappears from the check box, disabling that function. If you click the check box again, it marks the check box, which enables the function. A check mark appears.

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Display Splash screen	Displays the MIPAV opening splash screen, or title screen, when MIPAV is started. By default, this check box is clear.
Show Scripting toolbar	Shows the Scripting toolbar, which you can use to create and run scripts, in the MIPAV window. By default, this check box is clear.
Show Paint toolbar	Shows the Paint toolbar, which allows you to paint directly on images. By default, this check box is clear.
Show Paint border	
Save all on save	Saves the active image and all VOIs presently displayed on the image so that the next time you open the image MIPAV opens the image and VOIs. The VOIs are saved in a subdirectory of the directory in which the image is stored. By default, this check box is clear.

MIPAV Options

Global settings

☑ Display Splash screen
☑ Show Scripting toolbar
☐ Show Paint toolbar
☑ Show paint border
☐ Save all on save
☐ Save dialog settings
☐ Save XML header with Analyze images
☐ Save thumbnails for XML files
☐ Compress image in zip format when saved as XML
☐ Use platform-style File dialog boxes
☐ Record history
☑ Check memory options in start-up (LAX) file against preferences
☐ Check on closing frame?
☐ Redirect errors to file: C:\ProjectMipav\mipav.log

Default AVI frame rate:	10.0
Debugging output:	Off ▼
Recently used image list:	4 ▼
File filter default:	Medical
Crosshair cursor color:	Default ▼
Active image border color:	▉

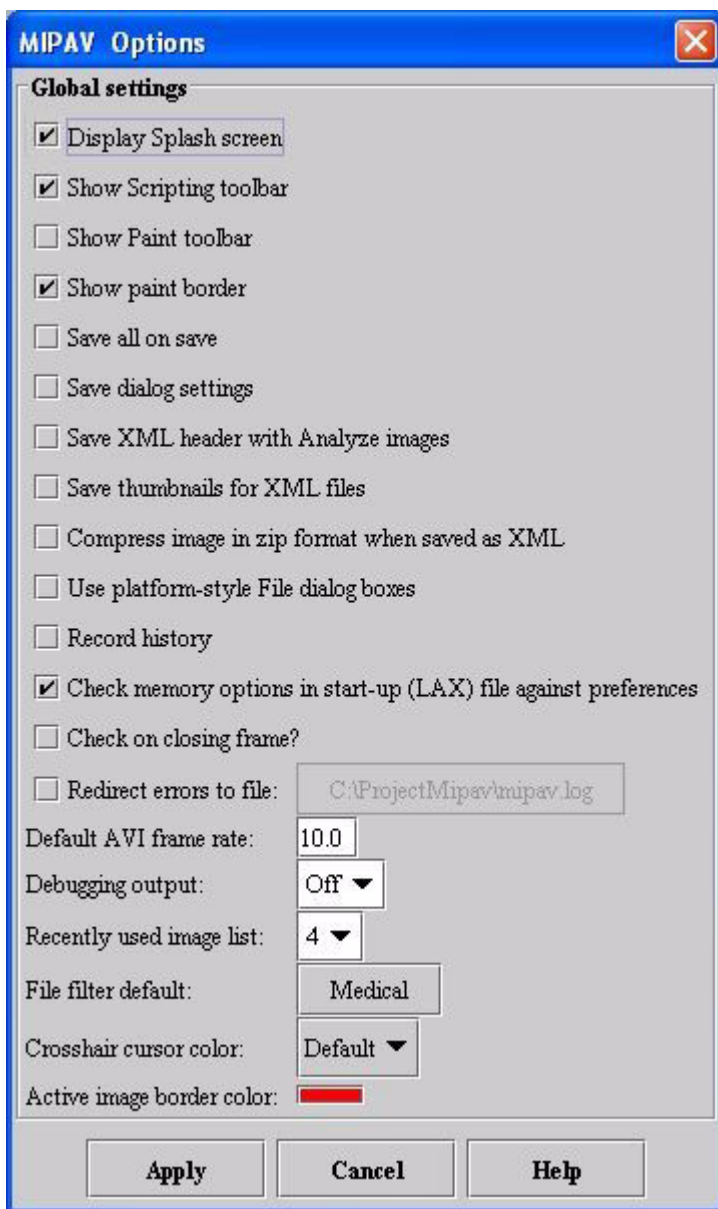Apply   Cancel   Help

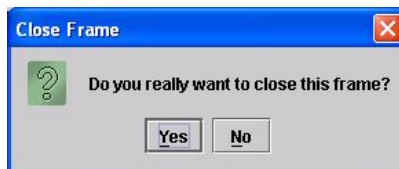**Figure 62. MIPAV Options dialog box**

Save dialog settings	Saves the settings you specified on algorithm dialog boxes so that the next time you use the algorithms, your specific settings override the default settings.
	By default, this check box is clear.
Save XML header with Anaylyze images	
Save thumbnails for XML files	
Compress image in zip format when saved as XML	Compresses images in a zip format when they are saved in XML format. When an image is saved in XML format, MIPAV produces a RAW file that describes the image and an XML file that includes image attributes. When you select this check box, MIPAV compresses only the RAW file, which compensates for the size of the RAW file.
	By default, this check box is clear.
Use platform-style File dialog boxes	Uses the style of Open and Save dialog boxes that are provided with the operating system of your computer, rather than the MIPAV style. For more information, refer to "Using platform-specific Open and Save dialog boxes" on page 90.
	By default, this check box is clear.
Record history	Keeps a record of all of the actions—algorithms and utilities—performed on images. The history may be viewed on the History page in the Image Attributes dialog box while the actions are performed or in the XML file when an image is saved to an XML file.
	By default, this check box is clear.
Check memory options in start-up (LAX) file against preferences	Enables MIPAV developers to debug the program. If you experience problems with the program, you may be asked to select this check box.
	Recommendation: Do not select this check box unless otherwise instructed by MIPAV development.
	By default, this check box is clear.
Check on closing frame?	Adds messages to confirm deletions of images. By default, this check box is clear.

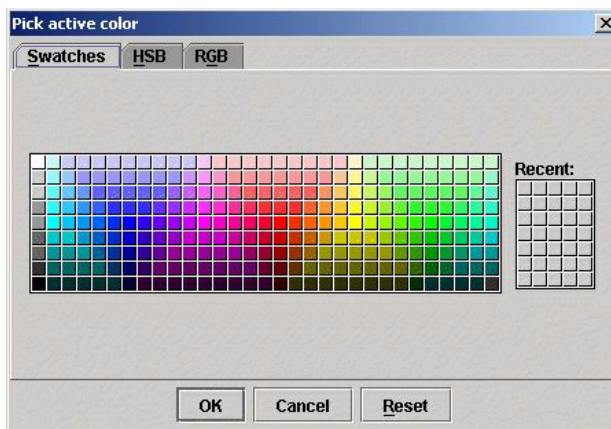**Figure 62. MIPAV Options dialog box (continued)**

Redirect errors to file	Records errors in the MIPAV log file for use by MIPAV developers in debugging the program. If you experience problems with the program, you may be asked to select this check box. **Recommendation:** Do not select this check box unless otherwise instructed by MIPAV development. By default, this check box is clear.
Default AVI frame rate	Sets the default frame rate for AVI images to the rate you specify. By default, the rate is 10.
Debugging output	Tracks debugging information and error messages generated by MIPAV during a session. For more information, refer to "Placing or removing MIPAV from debug mode" on page 95. **Recommendation:** Do not select this check box unless otherwise instructed by MIPAV development. By default, this check box is Off.
Recently used image list	Specifies the number of recently displayed images that appear near the bottom of the File menu on the MIPAV window. To open a recently displayed image, simply select the image on the File menu. The number of images that can be displayed can be from 2 to 9. By default, the number of images displayed on the File menu is 4.
File filter default	Specifies the types of files that should be shown in the Files of type box in the Open Image and Save Image as dialog boxes. Refer to "Choosing the default file types to display or save" on page 104 for more information.
Crosshair cursor color	Specifies the color of the crosshair cursor. You can choose from several colors and styles. By default, the color is set to "Default."
Active image border color	Specifies the color of the border around images. When you click on this box, the Pick Active Color dialog box, which allows you to select a different color, opens. By default, the color is red.

Figure 62. MIPAV Options dialog box (continued)

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Apply	Saves and immediately applies all of the selected parameters in this dialog box.
Cancel	Disregards any changes you made in this dialog box, closes the dialog box, and does not save the specified options.
Help	Displays online help for this dialog box

Figure 62. MIPAV Options dialog box (continued)

To show the splash screen

After hiding the splash screen, you may later decide to display it.

1 Select Help > Program Options. The MIPAV Options dialog box (Figure 62) opens.

2 Mark Display Splash Screen. A check mark appears in the check box.

3 Click Apply.

4 Click Close.

After you quit MIPAV and then start it again, the splash screen appears.

Using platform-specific Open and Save dialog boxes

By default, MIPAV uses its own version of Open and Save dialog boxes, which provide you with the ability to assign aliases, or shortcuts, to frequently used images. Aliases make it easy to locate images, a feature that may be attractive if you work with the same images for a period of time. However, you may prefer instead to use the style of Open and Save dialog boxes that are provided with the operating system of your computer. To do so, you need to select the Use platform-style File dialog boxes check box in the MIPAV Options dialog box (Figure 63 on page 91).

If this check box is selected and your computer is running Microsoft Windows, MIPAV displays the Windows style of Open and Save dialog boxes. If you use a Sun terminal, when this check box is selected, MIPAV displays the standard Unix-style Open and Save dialog boxes. On Apple MacIntosh computers, MIPAV displays dialog boxes that are standard with that operating system.

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To use platform-specific dialog boxes

1 Select Help > Program Options. The MIPAV Options dialog box (Figure 63 on page 91) opens.

2 Mark Use platform-style File dialog boxes. A check mark appears in the check box.

3 Click Apply.
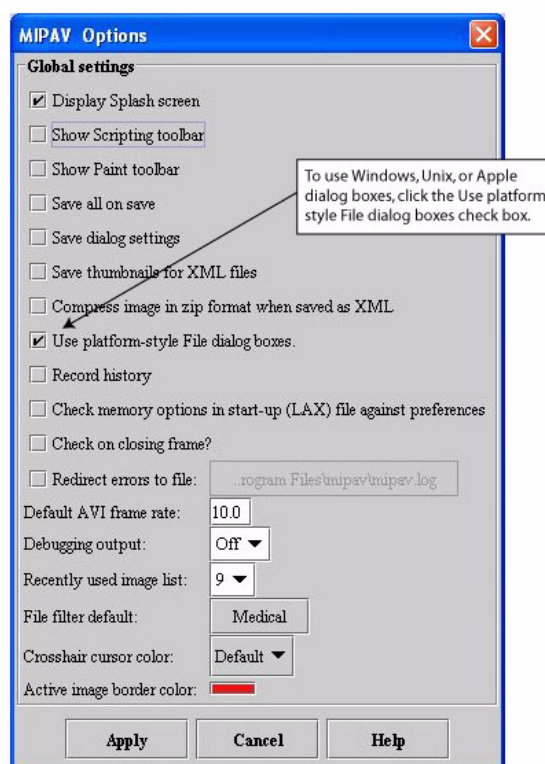
4 Click Close. The dialog box closes.

Figure 63. MIPAV Options dialog box showing Use platform-style File dialog boxes check box

Showing and hiding toolbars

After you open an image in MIPAV and the MIPAV window expands to display all of its menus, you can decide which toolbars should appear. By default, the window displays the VOI and Image toolbars.

The Toolbars menu contains check boxes for each of the four toolbars:

- **VOI toolbar.** Volume of interest toolbar (Figure 64). The VOI toolbar contains tools that help you in selecting the specific area of interest on the image.

- **Paint.** The Paint toolbar (Figure 65) includes tools that allow you to add, adjust, or remove colors and color intensity, erase paint, and adjust the opacity level of the paint.
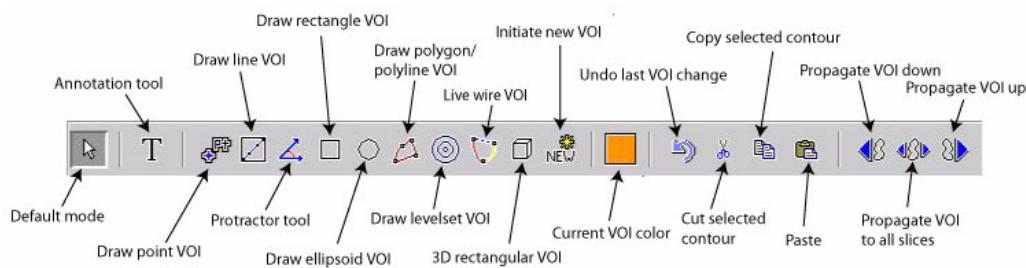

Figure 64. VOI toolbar

- **Scripting.** The Scripting toolbar allows you to locate and run previously recorded scripts, or macros, that contain two or more algorithms on images.
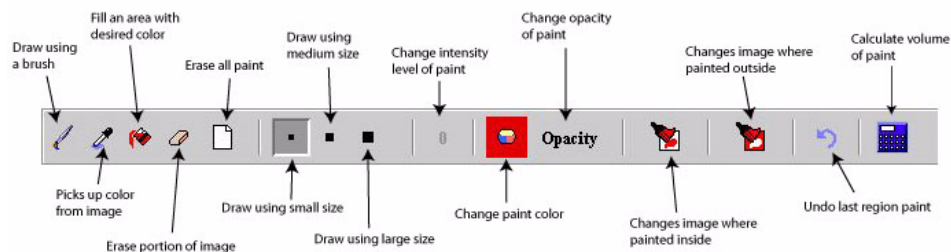

Figure 65. Paint toolbar

- **Image.** The Image toolbar (Figure 67) includes tools for opening, printing, saving, maximizing, and minimizing an image; converting an image from gray scale to color or from color to gray scale; and adding

to and removing slices from an image or changing their order; and rotating, cropping, and flipping an image.
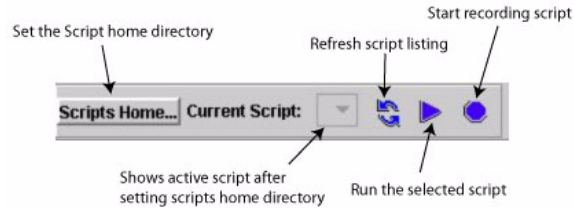
Figure 66. Scripting toolbar

By marking or clearing these check boxes, you can choose which toolbars to display and which to hide. For example, suppose you just started MIPAV a moment ago. You then open an image. The MIPAV window expands in size and displays its full complement of menus. Although it displays the VOI, Scripting, and Image toolbars, you want to work with the Paint toolbar as well as the Image toolbars. However, you don't need to use the VOI and Scripting toolbars.

Figure 67. Image toolbar

To hide the VOI and Scripting toolbars and display the Paint toolbar

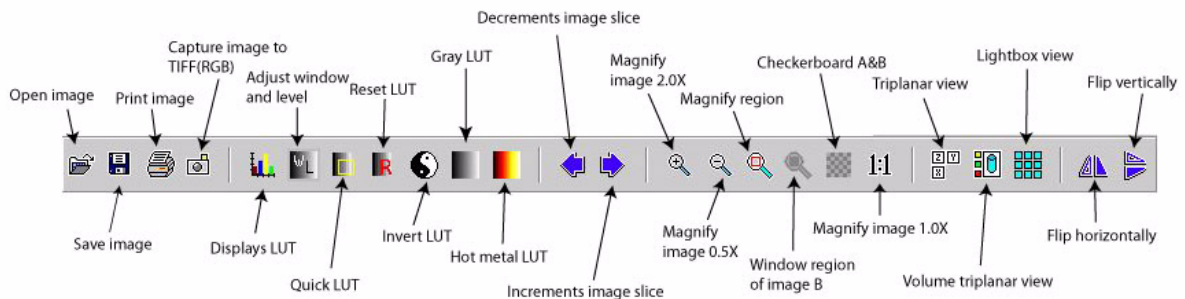**1** Select Toolbars > VOI to hide the VOI toolbar. MIPAV removes the check mark from the check box and removes the VOI toolbar from the MIPAV window.

Figure 68. Toolbars menu in the MIPAV window

2 Select Toolbars > Scripting to hide the Scripting toolbar. MIPAV removes the check mark from the check box and removes the Scripting toolbar from the MIPAV window.

3 Select Toolbars > Paint to display the Paint toolbar. The program marks the check box and displays the Paint toolbar in the MIPAV window.

Because the Image toolbar is already displayed, you do not need to do anything.

To always show the Scripting or Paint toolbars

You may want MIPAV to always show the Scripting toolbar, the Paint toolbar, or both when the program starts. These options are available on the MIPAV Options dialog box.

1 Select Help > Program Options in the MIPAV window. The MIPAV Options dialog box (Figure 62 on page 87) opens.

2 Mark Show Scripting toolbar, Show Paint toolbar, or both (Figure 69).

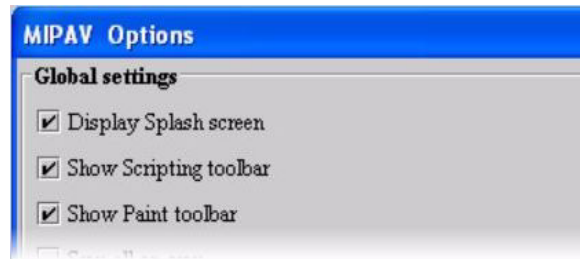Check marks appear in the check boxes you selected.

Figure 69. Toolbar choices on the MIPAV Options dialog box

3 Click Apply.

4 Click Close. When you start MIPAV again, the toolbars that you selected appear in the MIPAV window.

Placing or removing MIPAV from debug mode

You can track debugging information and error messages generated by MIPAV during a session by placing it in debug mode. If errors occur during the session, the program displays any error messages in the Output window on the Debug page. By default, the debug mode is off when you start the program.

Recommendation: The debugging information is primarily intended for MIPAV developers and not for users. The best course for users is to leave the debug mode *Off* unless a MIPAV developer asks for you to turn it on.

PLACING MIPAV IN DEBUG MODE

To turn the debug mode on

1 Select Help > Program Options. The MIPAV Options dialog box (Figure 62 on page 87) opens.

2 Note that the initial value for Debugging output is Off.

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3 Select the arrow in Debugging output to display the list of debugging modes and then select one of the five levels of severity for the debug mode (Figure 70).
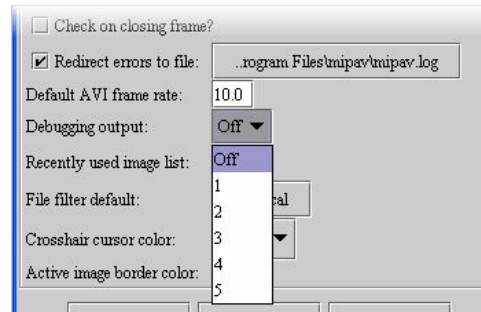

Figure 70. Debugging output choices on the MIPAV Options dialog box

Note: The five debugging levels correlate to the amount of debugging information provided on the Debug page and the amount of computer memory used. Level *1* provides the least amount of debugging information, and level *5* provides highest level of the debugging information.

4 Click Apply.

5 Click Close. From this point on, MIPAV places debugging data on the Debug page in the Output window (Figure 71).
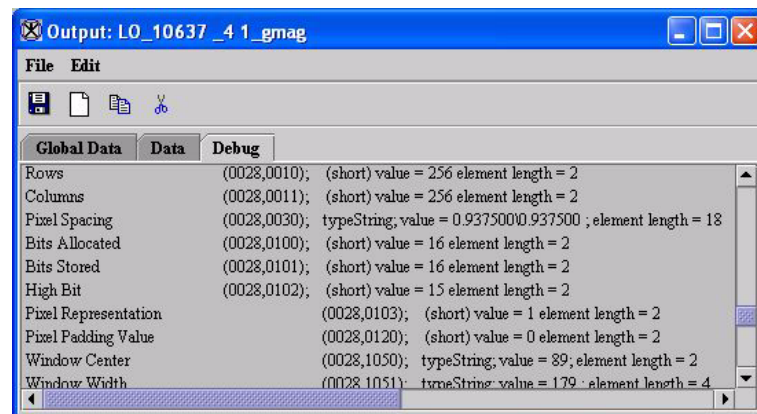

Figure 71. Output window showing the Debug page

Note: If you've contacted MIPAV developers about a problem with the program, they may ask you to save the debugging data in a text file. To do this, you would mark Redirect errors to file and type the name of the file in the box beside the check box. You can then send the file to them via e-mail.

To turn the debug mode off (remove MIPAV from debug mode)

1 Select Help > Program Options. The MIPAV Options dialog box (Figure 62 on page 87) opens.

2 Select the arrow in Debugging output to display the list of options and select *Off*.

3 Click Apply.

4 Click Close.

When the debug mode is off, no error messages display on the Debug page in the Output window.

Managing memory resources

MIPAV requires at least 35 Mb of random access memory (RAM). Additional memory is needed to correctly display image files and to quantify the data. To determine the amount of additional memory needed, multiply the size of the image file that you want to display by 10. Thus, if an image file is 2 Mb, you must allocate an additional 20 Mb of RAM (in addition to the base of 35 Mb) for it to display correctly. Because memory requirements fluctuate depending on the size and number of image files open, it may be necessary to allocate more memory during a session.

As Java-based programs run, they often leave old variables, objects, or constructors in memory. For instance, if you delineate a VOI, the coordinates of the contours may remain in memory even after you close the image. Java provides a method called the *garbage collector* that clears all unnecessarily reserved memory. Generally, the software does this automatically when free memory becomes very limited. However, you can run the garbage collector at any time to free memory by clicking on the Free Memory button.

The first step is to view how much memory is currently being used and to free unnecessarily reserved memory. Then, if necessary, you may need to allocate additional memory.

To determine how much memory is currently being used by MIPAV

1 Select Help > Memory Usage in the MIPAV window. The Memory Monitor dialog box appears (Figure 72).

When MIPAV performs a function, such as visualizing an image file, it uses memory. When the function completes (i.e., the visualized image closed), you manually free the memory so it can be used for another function.

The Memory Monitor dialog box shows how much memory is allocated and how much memory has been used. The vertical bar on the right of the window displays a pictorial representation of the ratio of allocated memory or amount of memory used. The chart shows the memory usage for the past 3 minutes and 45 seconds. The chart is updated every second.

If you want to constantly monitor your memory resources, you can leave the Memory Monitor dialog box open on your desktop. Otherwise, close it by clicking Close.
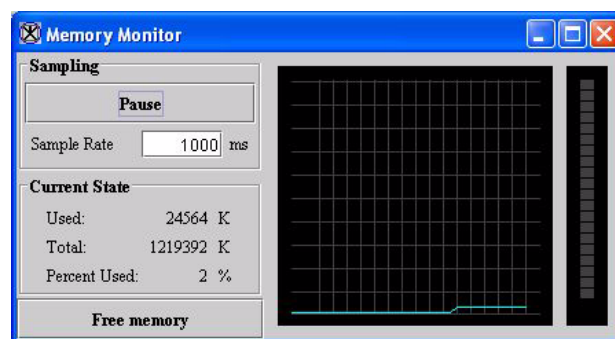
2 Click Free memory to free memory.

Figure 72. Memory Monitor dialog box

To allocate more memory

If you need to need more memory, you can allocate virtual memory or disk swap space if there is free space on your hard drive. For instructions on how to do this, refer to the documentation for your system. If you cannot assign more virtual memory or disk swap space, you may need to install additional memory.

If more than 100 Mb of physical memory, virtual memory, or disk swap space were allocated, then you must indicate the amount so that MIPAV can take full advantage of the additional memory.

1 Select Help > Memory allocation in the MIPAV window. The Change Java.Runtime Memory Allocation dialog box (Figure 73) opens.

2 Change the maximum heap size number so that is reflects the maximum amount of memory that should be allocated.

   In a Microsoft Windows system, you can specify a maximum to 1.2 or 1.3 Gb. If additional memory is needed, MIPAV allocates it until the memory reaches the maximum heap size that you specify.
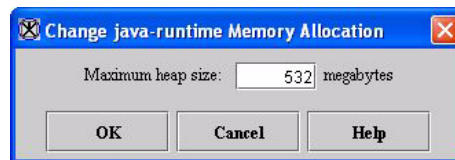
3 Click OK to close the dialog box.

Figure 73. Change Java-Runtime Memory Allocation dialog box

Note: You must restart of MIPAV for the changes to take effect. To do this, select File > Exit - MIPAV in the MIPAV window to quit MIPAV. Then, restart MIPAV.

Saving a history of actions on images

MIPAV allows you to keep a history of all of the actions—the algorithms and utilities—that you perform on images. The history includes the specific parameters that were set for the action. In addition, if you save the images

as XML, the history of actions and their parameters appears in the dataset attributes section near the beginning of the MIPAV header file (the XML file). Each action appears between the <HISTORY> and </HISTORY> tags.

By default, MIPAV does *not* record a history of actions unless you specifically select the Record history check box in the MIPAV Options dialog box.

To record a history of actions taken on images

1 Select Help > Program Options in the MIPAV window. The MIPAV Options dialog box (Figure 74) appears.

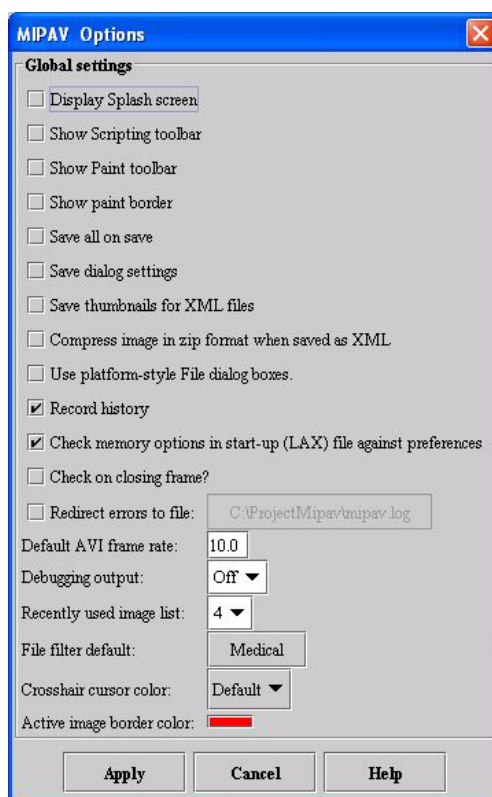2 Mark Record history. A check mark appears in the check box (Figure 74).

Figure 74. Record History check box on the MIPAV Options dialog box

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3 Click Apply. From this point on, MIPAV records the actions performed on all images until you clear the Record history check box.

To view the history of actions as they are performed

The History page in the Image Attributes dialog box allows you to view the list of actions *immediately* after they are performed. The following example illustrates how to do this:

1 Make sure that the Record history check box (Figure 74 on page 100) was selected in the MIPAV Options dialog box.

2 Open a sample image.

3 Select Image > Attributes > Edit attributes. The Image Attributes dialog box opens.

4 Select History. The History page appears.

5 Click the image to make it the active window.

6 Select Utilities > Flip > Horizontal.

The image is flipped horizontally, and the words "Flip(Y_AXIS)" appear on the History page in the Image Attributes dialog box.

Tip: You can type directly onto the History page of the Image Attributes dialog box, letting you add comments to the history, which you can save and print.

7 Perform other actions on the image, such as algorithms or other utilities. Note that these actions appear on the History page (Figure 75).
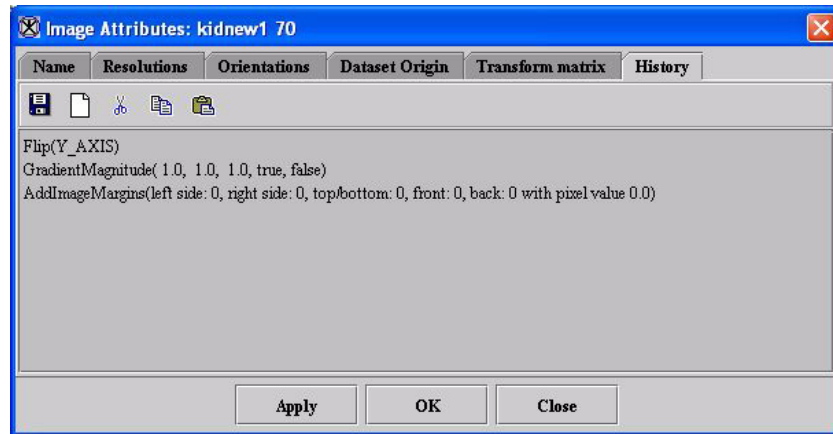
Figure 75. History page showing actions performed on an image

Under What Circumstances Do Actions Fail to Appear on the History Page?

If MIPAV is fully operational, actions performed on an image always appear on the History page of the Image Attributes dialog box and in the XML file for that image. However, it's important to know whether the actions were performed on the *original image* or on the *replacement image.*

 Several algorithms and utilities offer a choice of either generating a new image (New image check box) or replacing the original image (Replace image check box). If you choose New image and want to see the actions performed on that image, you must select Image > Attributes > Edit Attributes to open an Image Attributes dialog box for the new image. If, however, you select Replace image, the History page on the Image Attributes dialog box for the original image displays the actions.

To illustrate this point, open a sample image; select Image > Attributes > Edit Attributes to display the Image Attributes dialog box; and select History to display the History page. Perform an action such as Utilities > Image Margins, mark New image in the dialog box, and then click OK. Notice that the action does not appear on the History page. Click on the new image; select Image > Attributes > Edit Attributes; and select History. The History page shows the AddImageMargins action for the new image.

To view the history of actions recorded in the XML file

1 Save the sample image as an XML file by selecting File > Save Image as. The Save Image as dialog box opens.

2 Select the directory where you want to save the file in the Save in box.

3 Type the name of the file—use "SampleImage" as the file name—and type an ".xml" file extension in the File Name box so that the complete file name is "SampleImage.xml."

4 Click Save.

5 Open Windows Explorer by right-clicking on Start and then selecting Explore. The Windows Explorer window opens.

6 Navigate to the directory where you stored the XML file. This directory should have two files named "SampleImage": "SampleImage.raw" and "SampleImage.xml."

7 Double-click "SampleImage.xml." An internet browser page, such as Internet Explorer or Netscape Communicator, appears displaying an XML page (Figure 76).

Notice that, immediately after the <Dataset-attributes> tag, the following line appears:

    <History>Flip(Y_AXIS)</History>

Each action that you perform on the image appears between its own <History> and </History> tags.
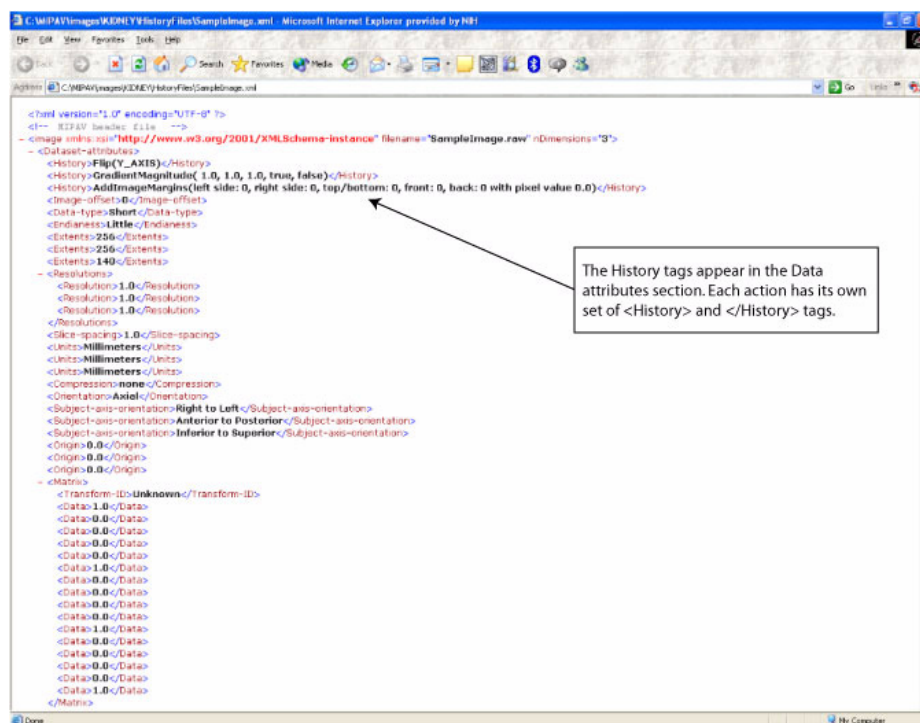
Figure 76. Actions recorded in an XML file

Choosing the default file types to display or save

When you using MIPAV, chances are that you are working with the same type of files every day or perhaps for a certain period of time. For example, suppose you normally work with medical files (files whose extensions are .dcm, .xml, .ima, .img, .mnc, .sig, .head). In this situation, when opening or saving images, you want to see only the medical files, not other file types. One of the ways of customizing MIPAV is the ability to show only specific types of files by default.

The File filter default box on the MIPAV Options dialog box allows you to choose which types of files should be shown in the Files of type box in the Open Image and Save Image as dialog boxes.

To choose the default file types to display or save

1 Select Help > Program Options. The MIPAV Options dialog box (Figure 77) opens.
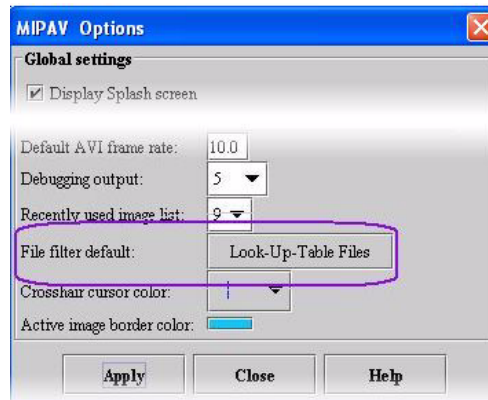

Figure 77. File filter default box on the MIPAV Options dialog box

2 Click File filter default. The Choose File Filter dialog box (Figure 78) appears.
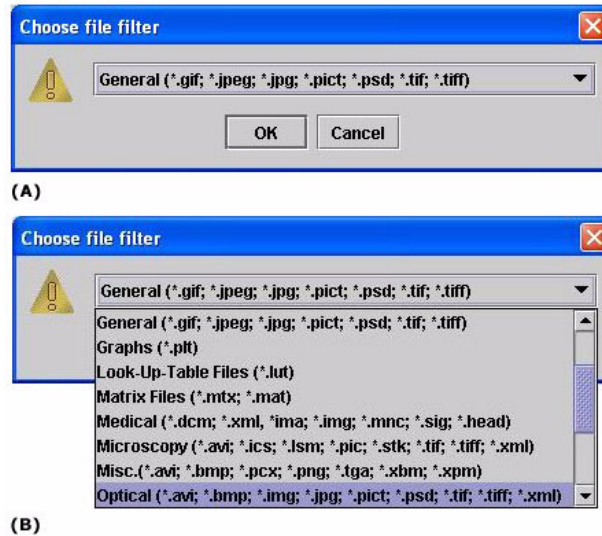
Figure 78. Choose File Filter dialog box: (A) As it appears initially and (B) showing the list of file filters

3 Select on the file filters. You can choose one of the following collections of file types:

- All (*.*)
- AVI (*.avi)
- Class files (*.class)
- FreeSurfer (*.asc)
- General (*.gif, *.jpeg, *.jpg, *.pict, *.psd, *.tif, *.tiff)
- Graphs (*.plt)
- Look-up tables files (*.lut)
- Matrix files (*.mtx, *.mat)
- Medical (*.dcm, *.xml, *.ima, *,img, *.mnc, *.sig, *.head)
- Microscopy (*.avi, *.ics, *.lsm, *.pic, *.stk, *.tif, *.tiff, *.xml)
- Misc. (*.avi, *.bmp, *.pcx, *.png, *.tga, *.xbm, *. xpm)
- Optical (*.avi, *.bmp, *.img, *.jpg, *.pict, *.psd, *.tif, *.tiff, *.xml)
- Project (*.xml)
- Script files (*.sct)
- Surface files (*.sur, *.wrl)
- Transfer function files (*.fun)

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- VOI files (*.voi)
- Nonlinear transformation files (*.nlt)

4 Click OK. The Choose File Type dialog box closes.

5 Click Apply in the MIPAV Options dialog box. This change takes effect immediately.

To verify that the filters you chose are used as the default filters

1 Select File > Open > Image(A). The Open Image dialog box appears. The Files of type box should show the filters you chose.

2 Select File > Save Image as. The Save Image as dialog box opens with the Files of type box listing the file filters you chose.
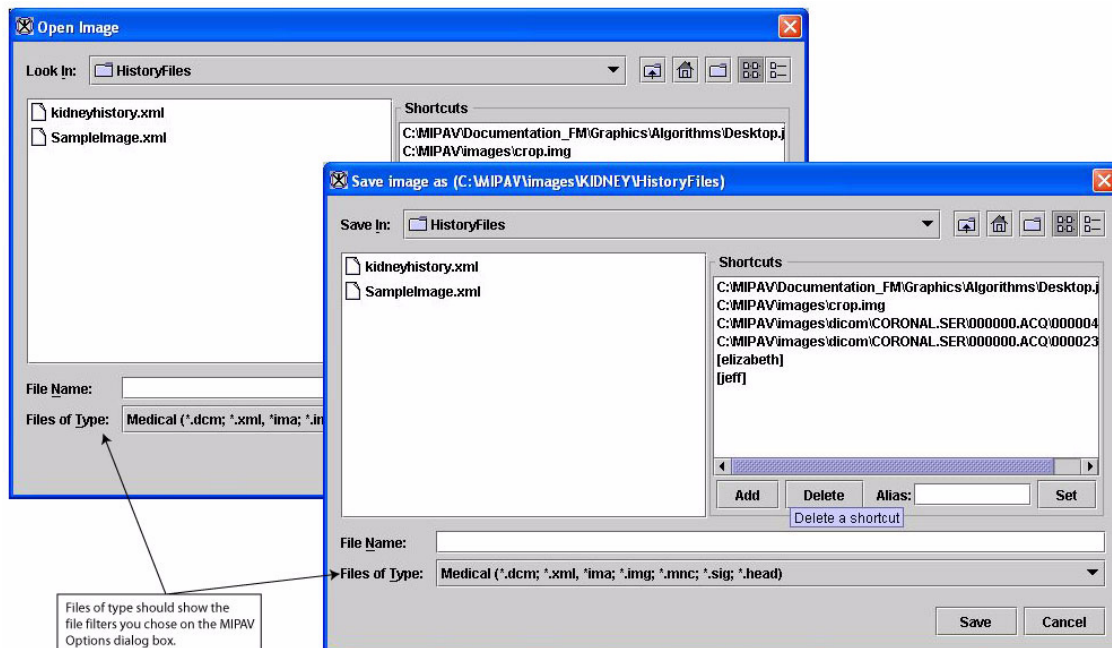

Figure 79. The default filters

Developing and using plug-in programs

A *plug-in* program allows you to add customized functionality to MIPAV. Before you create a plug-in, you should have a strong understanding of the underlying structure of MIPAV's software design and data structure. Because plug-ins are written in Java, you should also have a basic understanding of that programming language. After you create the plug-in, you must then install it. Once it is installed, you can access it from the Plug-Ins menu in the MIPAV window. Plug-ins are addressed in Chapter 11 in the *MIPAV User's Guide*.

Quitting MIPAV

To end a MIPAV session

1 Select File > Exit-MIPAV. The MIPAV-Exit dialog box (Figure 80) appears asking if you really want to exit the program.
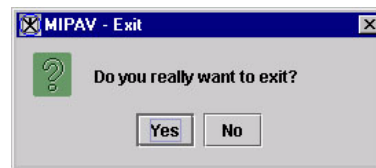
2 Click Yes to end the session.

Figure 80. Exit Confirmation dialog box

Tip: You can also exit MIPAV by clicking on Close ⊠ at the top right of the MIPAV window.

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